The American Journal of Surgery

EDITED BY THURSTON SCOTT WELTON, M.D., F.A.C.S.

May 1941

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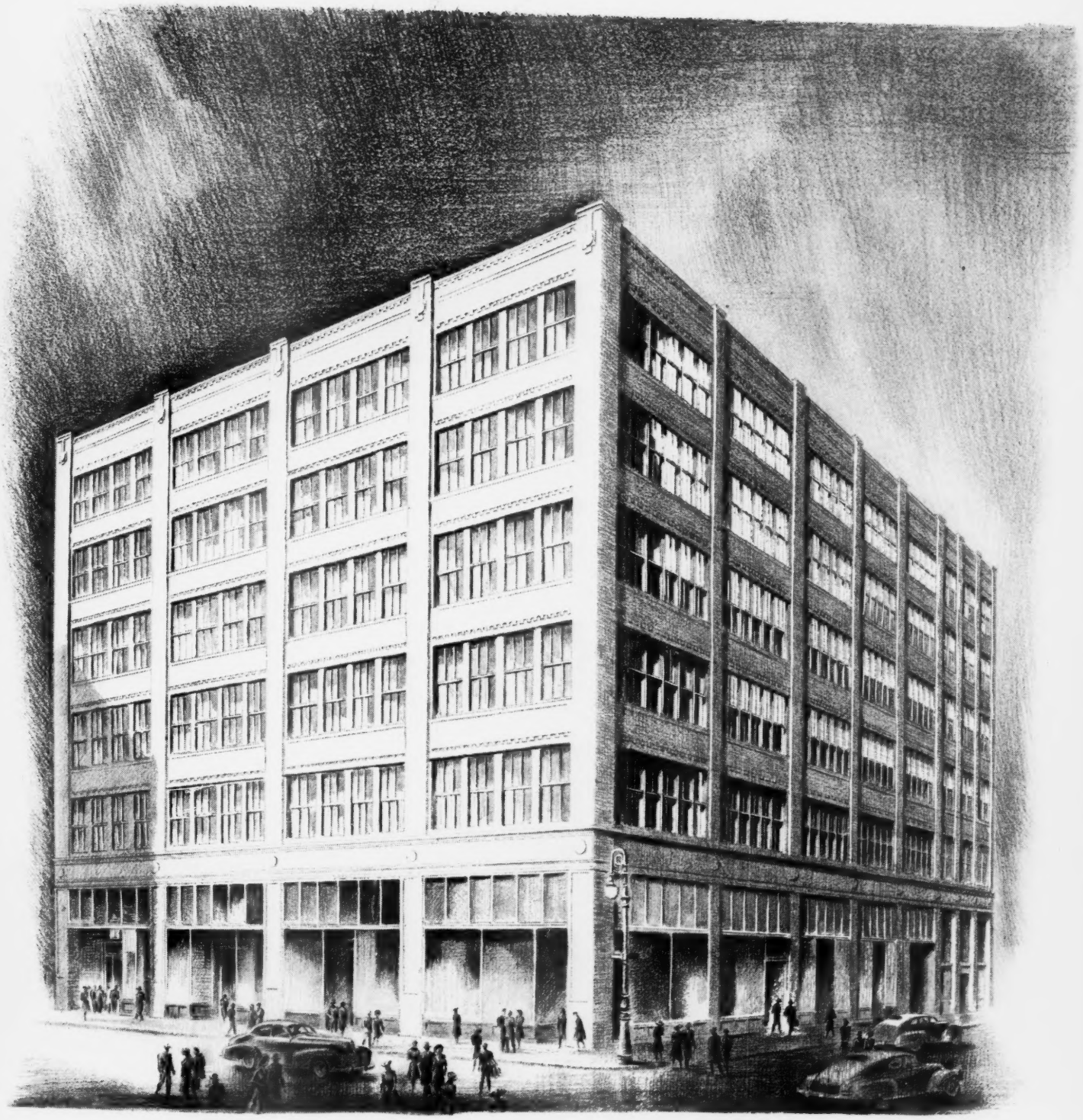

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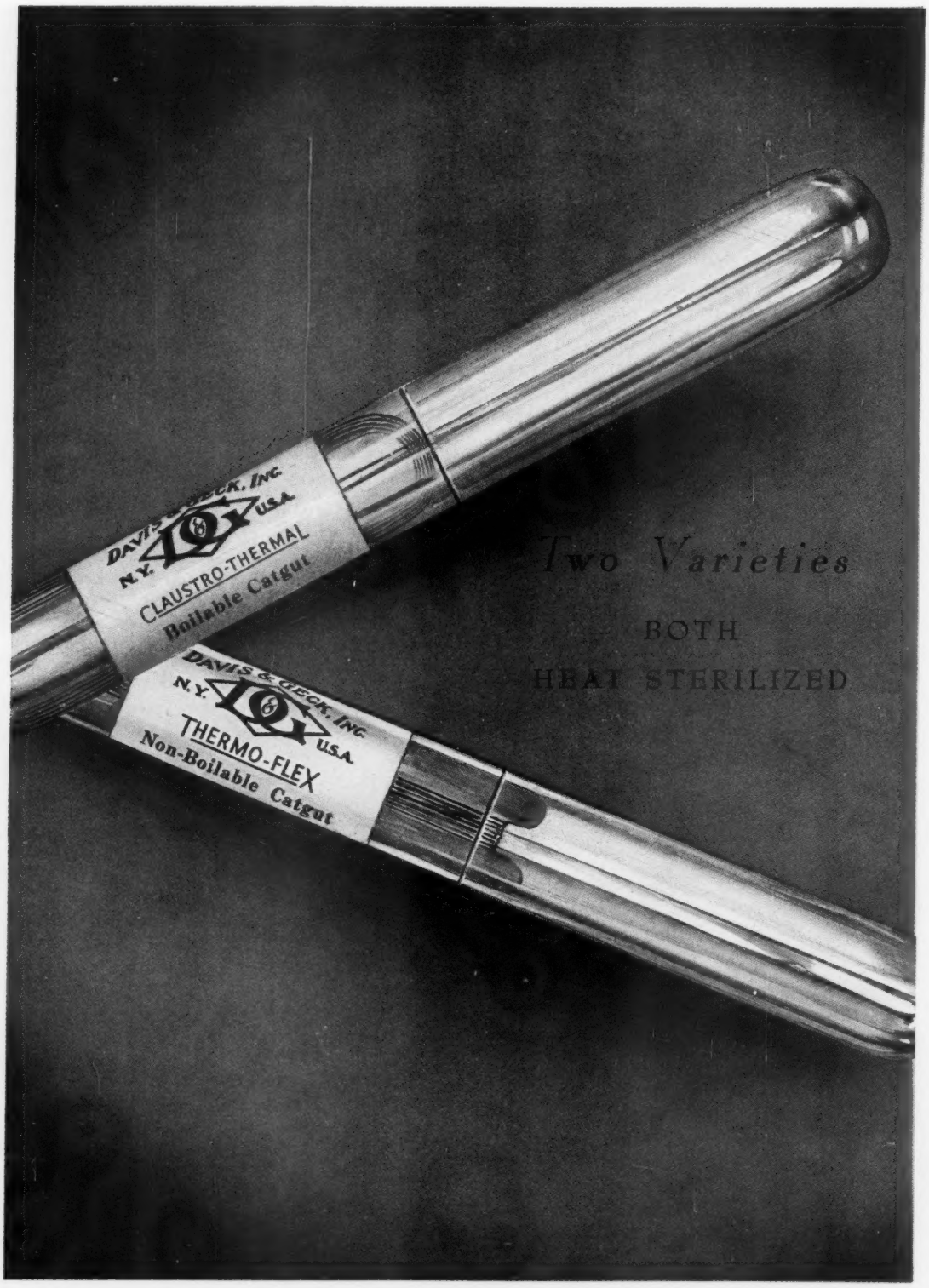

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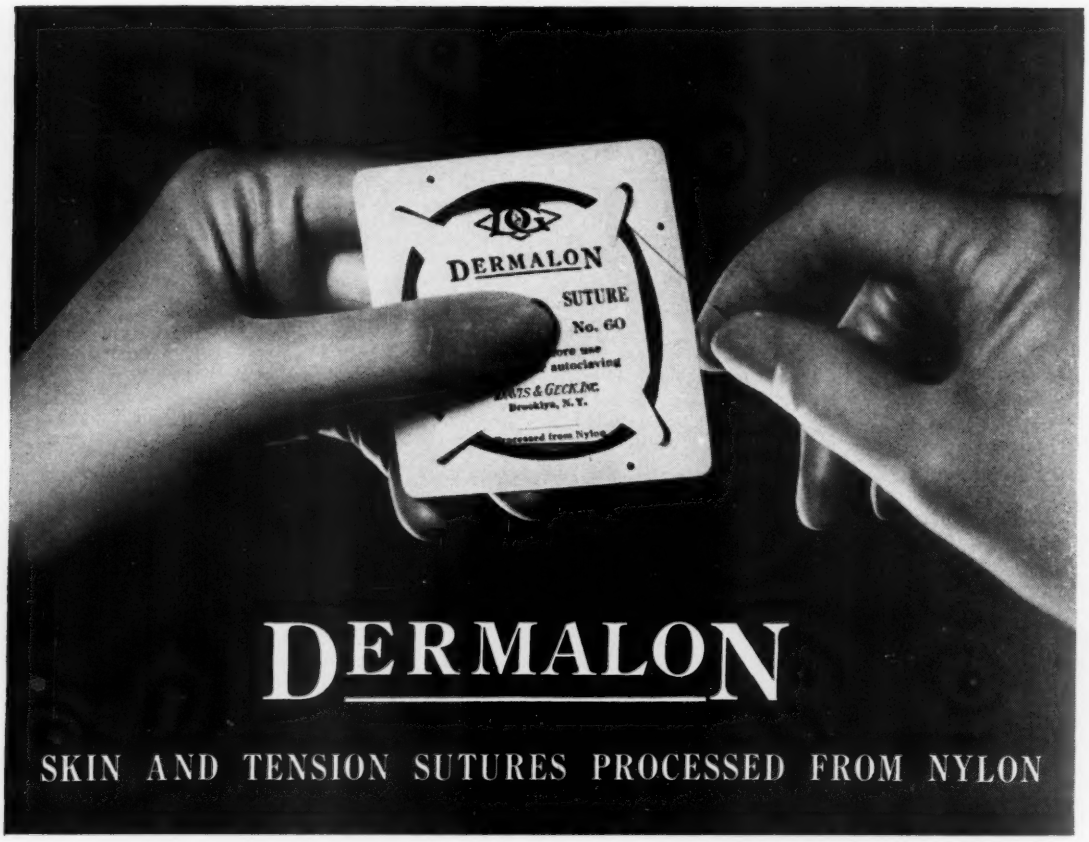

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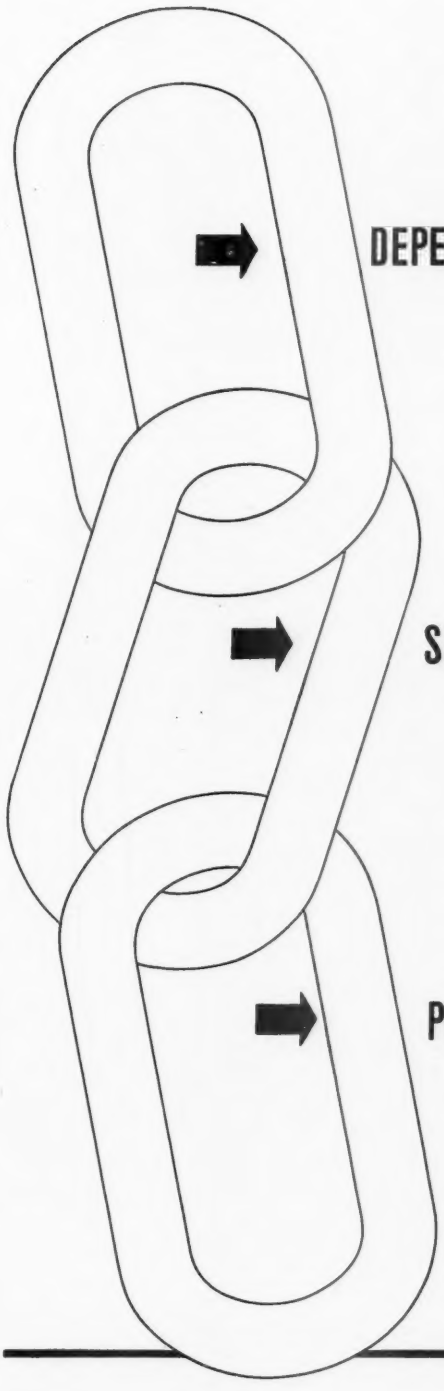

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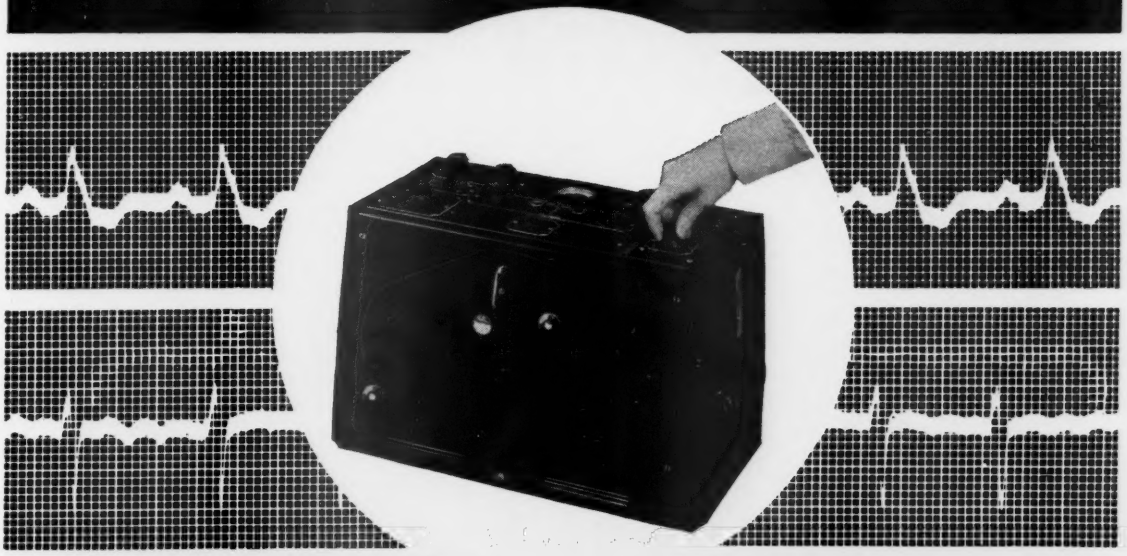

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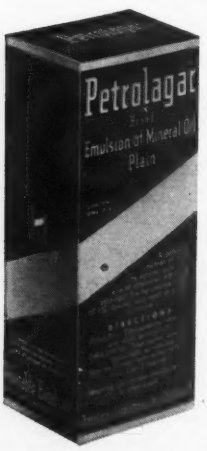

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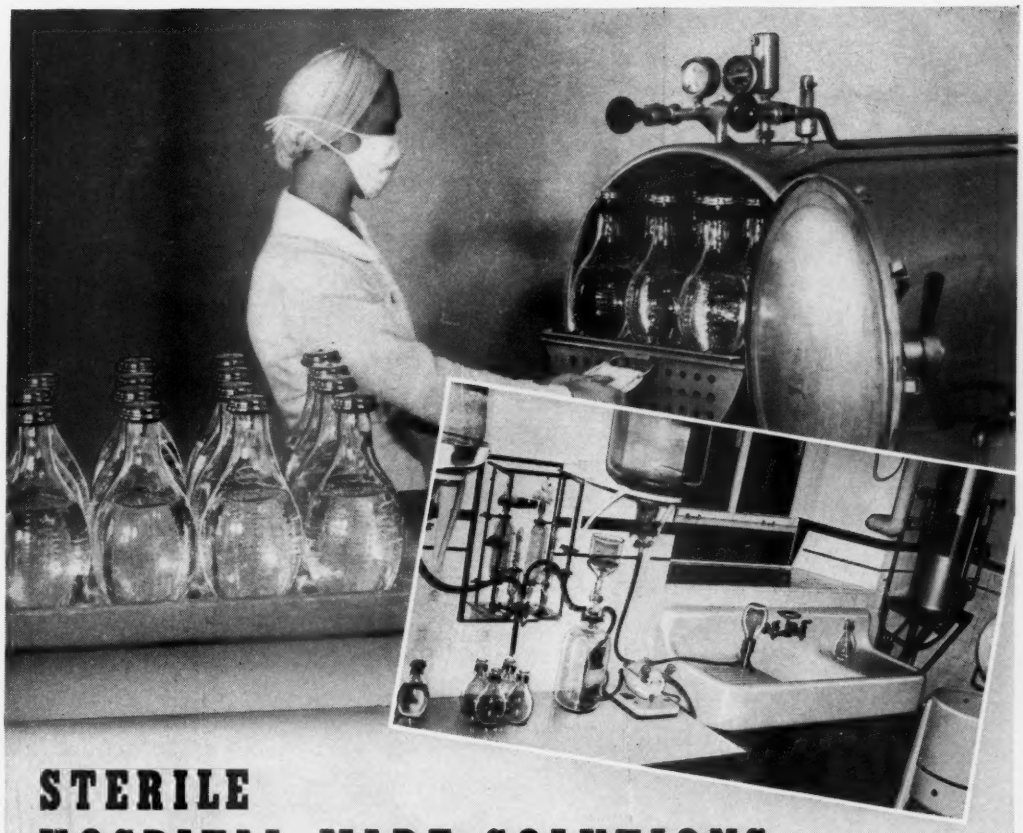

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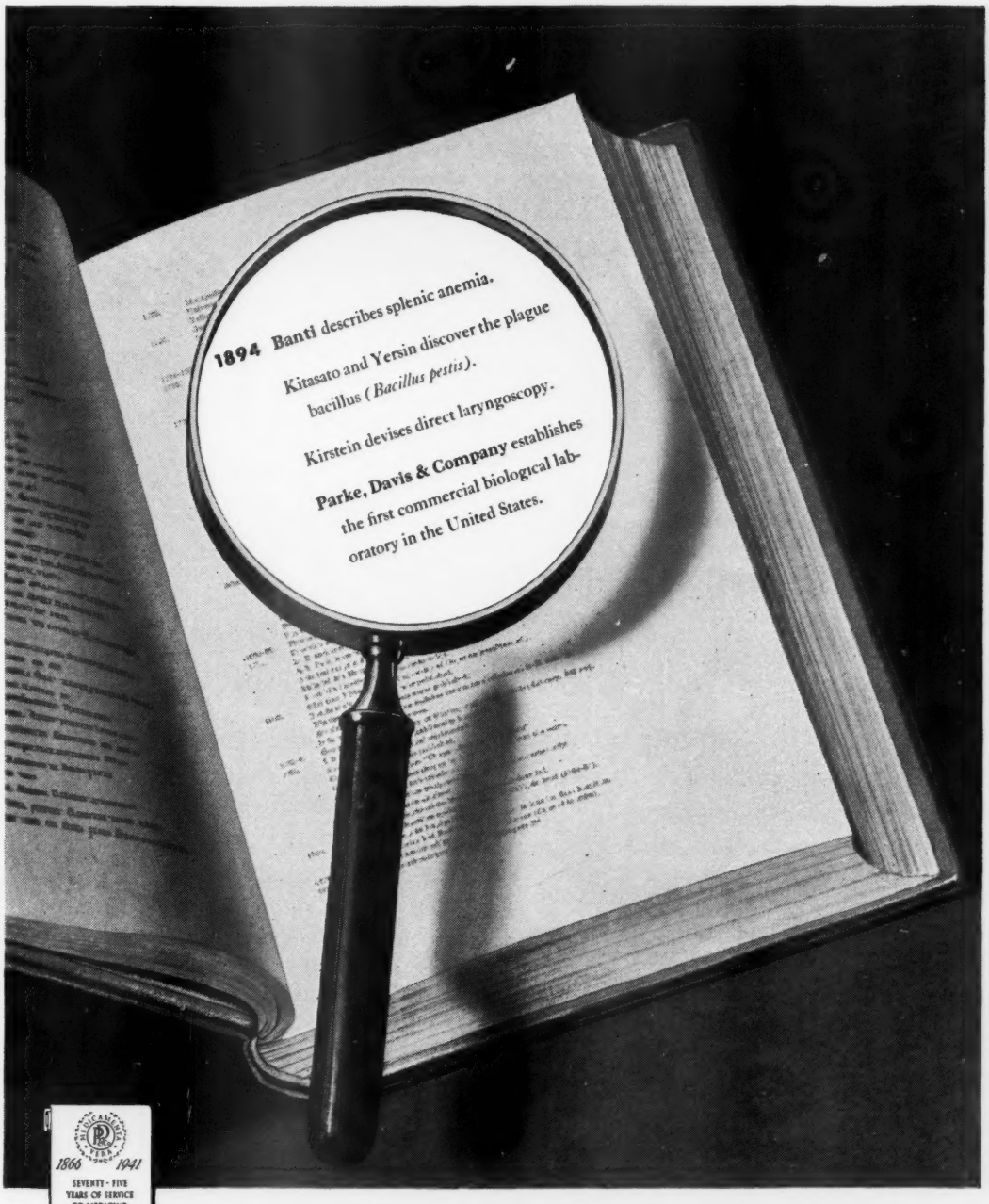
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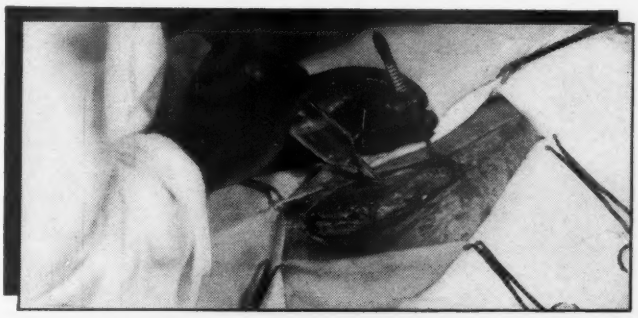

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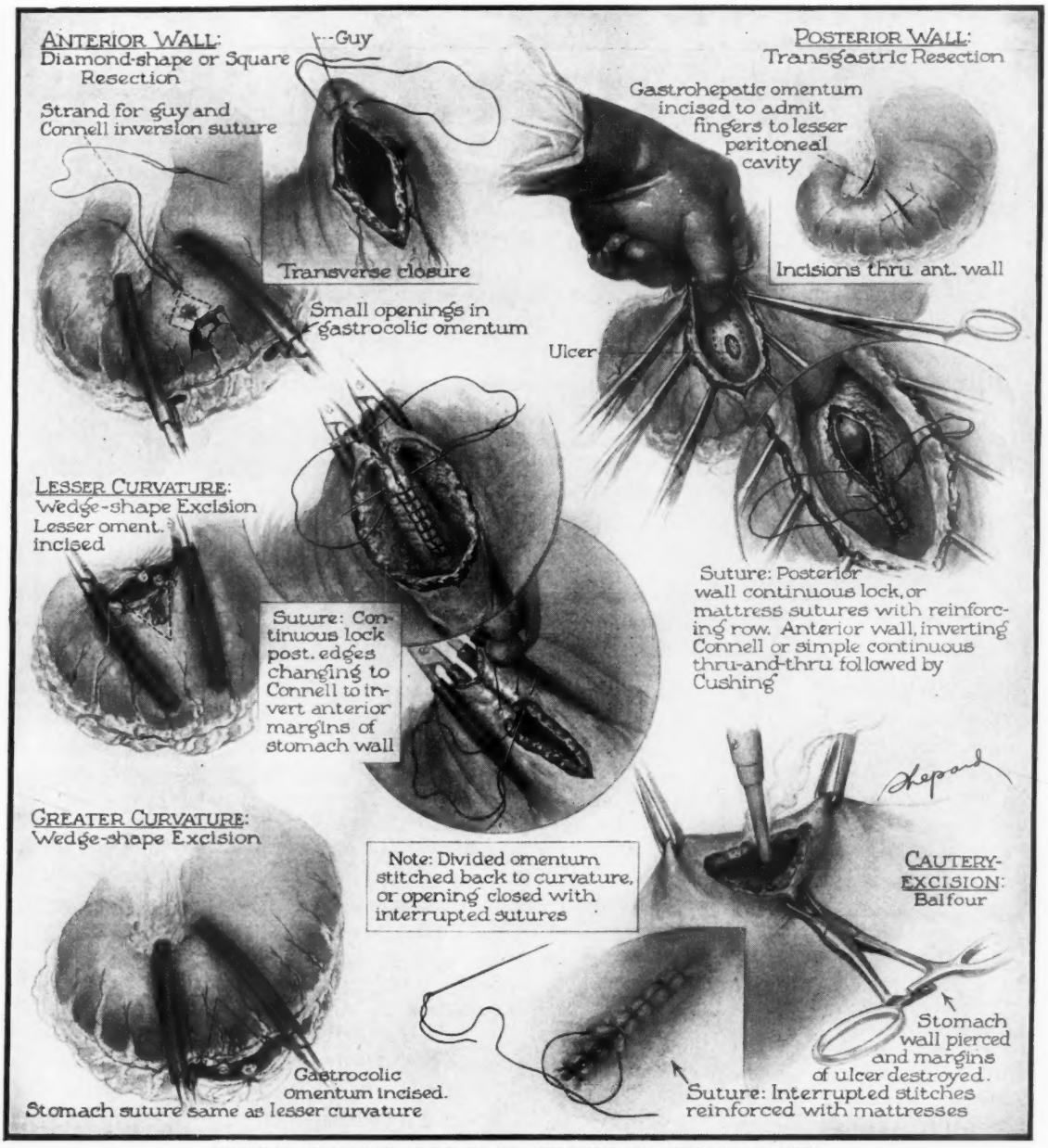
ANTERIOR WALL:
Diamond-shape or Square Resection
Guy
Strand for guy and Connell inversion suture
Transverse closure
POSTERIOR WALL:
Transgastric Resection
Gastrohepatic omentum incised to admit fingers to lesser peritoneal cavity
Incisions thru ant. wall
Small openings in gastrocolic omentum
Ulcer
LESSER CURVATURE:
Wedge-shape Excision
Lesser oment. incised
Suture: Continuous lock post. edges changing to Connell to invert anterior margins of stomach wall
Suture: Posterior wall continuous lock, or mattress sutures with reinforcing row. Anterior wall, inverting Connell or simple continuous thru-and-thru followed by Cushing
GREATER CURVATURE:
Wedge-shape Excision
Note: Divided omentum stitched back to curvature, or opening closed with interrupted sutures
CAUTERY-EXCISION:
Balfour
Stomach wall pierced and margins of ulcer destroyed.
Gastrocolic omentum incised.
Stomach suture same as lesser curvature
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OPERATIVE PROCEDURE—PLATE NO. 117—COPYRIGHT 1941, JOHNSON & JOHNSON

Gastric Ulcer

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NEW SERIES VOL. LII MAY, 1941 NUMBER TWO

Editorial

TRAUMATIC SURGERY AND THE WAR OF TOMORROW

IN these days of preparation for another war there is apparently much confusion surrounding the term "war surgery." Doubtless there is similar confusion as to the term "war medicine," but of this I am not competent to speak.

In the Great War, many of us had the opportunity of serving with surgical units of our Allies, and the practical experience then gained served us well when the time came to care for our own wounded. In retrospect, we recall that the actual service of American surgeons with their own army began at Cantigny in May, 1918, and ended in the Argonne, November 11, 1918. This meant only six months of direct contact with our own wounded, and hence many of us served longer with our Allies than we served with our own troops during the actual combat.

The present war differs technically from the last war in respect to the terrain, the type of combat, the increased use of tanks and airplanes, and in many other aspects, including a great increase in the noncombatant wounded. However—and this is is my subject—*the type of injury and the elements of treatment are essentially unchanged.*

Generally speaking, there are always two groups chiefly affected by war: combatants and noncombatants, but the injuries are usually identical. We can group these war injuries into five main classifications: wounds, burns, fractures, visceral and joint trauma. Differing often as to severity, these are also the prevalent peace time traumas. In the final analysis, trauma registers as the outcome of initial contusion or laceration, plus appropriate complications, of which shock, hemorrhage and infection are the chief. War surgery is traumatic surgery in the mass, and traumatic surgery is only a section of general surgery. In traumatology there is no merit in prefixing a special causative factor, such as industrial surgery, civil surgery, or military surgery inasmuch as there is essentially only one etiologic factor (violence) and only one physical effect (damage). In years gone by, "railroad spine" had a vogue that proved meaningless, just as had the term "shell shock." The factor to be stressed is that "trauma" means "a blow," whatever the surroundings, source, site or sequence. Much has been said as to the gains achieved for traumatology through the experience of the last war. My viewpoint is that the only indisputable gain was the final mass proof of the prophylactic efficacy of tetanus antitoxin.

Antiseptics proved valueless, and as a matter of fact, even the Carrel-Dakin method had been practically abandoned abroad before it became the vogue here. Dakin's solution was the 1914–1918 model of Labarraque's solution of 1814, each of them chlorines. Likewise débridement (de-

rived from the French "débrider," to unbridle) was supposed to be a new method, but actually the word itself and its connotations belong to the period of the Napoleonic Wars, a century prior to the First World War.

The originator and exponent of débridement was the great French Army Surgeon, Baron Dominique-Jean Larrey, now almost forgotten by us but who was remembered by Napoleon in his last will and testament by a bequest of 100,000 francs "to Larrey, the most virtuous man I have ever known." Strangely enough, Napoleon forgot his Generals but remembered this Surgeon-in-Chief to the Grand Armée who participated in sixty battles and 400 engagements. He was wounded three times, performed as many as 200 amputations in twenty-four hours at Borodino, and originated first aid to the wounded through the medium of the celebrated "flying ambulances."

Of all the elements that mean success in the treatment of the injured, time is of the essence. For many years I have referred to this factor as the "Golden Period" in traumatic surgery, to indicate that an injury should be treated within the first six hours post-trauma. During that period of "lightning attack" our chances of overwhelming the enemy, infection, are greatest, and delay may mean disaster. The analogy in general surgery is apt, for we know that success is usually achieved if we can operate within six hours after the onset of a ruptured appendix, or a ruptured duodenal ulcer.

In this present war, the opportunities for speedier care of the injured will probably be greater because of the terrain, and motor and airplane transport. Likewise the prevalence of gas gangrene and tetanus will be less inasmuch as precombat immunizing will be possible. Streptococcic and staphylococcic infection will largely yield to the sulfonamides, and thus chemotherapy will further reduce our posttraumatic complications.

Fractures of the compound type are a main problem in any war, and I am told that the newer type of shells and bombs are so designed that the burst is distributed closer to the ground, thus the lower limbs will be more often involved. In civil life compound fractures usually occur because the broken bone extrudes (from within out) and thus infection is less often of the buried type. In war fractures, the missile penetrates the soft parts first (from without in), thus carrying infection deeply and damaging the soft part coverage en route. There is also the added factor of infected soil, clothing and skin, all of which mean that every compound fracture is an infected fracture—in reality, potential osteomyelitis. As a matter of proved clinical experience, we have long known that every wound not made with surgical intent is already infected and should be so regarded. Thus in stark reality, *the* enemy is infection, and to be effectively overcome we can place reliance only on two factors: one is the *time* factor and the other the *sterilizing* factor. The *time* factor has already been mentioned; we usually win if we attack in the first six hours post-trauma, and we usually lose if we attack thereafter.

The *sterilizing* factor is also two-fold: We can use débridement (mechanical or external sterilization), or we can use drugs (chemical or internal sterilization)

Débridement is effective when three criteria are attained, namely, normal color, the occurrence of bleeding and muscle contraction, as incidents in the surgical nonsacrificial excision of damaged tissue. *Chemical* security is effective when organisms succumb. Various incidentals in treatment also play a part, one of importance being immobilization, and the other avoidance of re-infection in early or imperfect dressings.

Immobilization is being stressed now as a new phase in the treatment of wounds and fractures, the assertion being that plaster of Paris or other types of inclusion are the chief elements of importance. There is nothing fundamentally new in this assertion inasmuch as it is only a modification of the old principle of rest and splintage. It

is not to be forgotten that adequate sterilization is a preliminary to any type of immobilization. Germs can live only on damaged tissue, and this is now, as always, a guiding principle, applicable alike to civil as well as to war injuries.

The search for the *sterilisia magna* in wound treatment has tormented the profession for centuries and at present the fulfillment of this dream of surgeons is a long step nearer because of the sulfonamides. However, a sterile field is the necessary adjunct, hence surgical asepsis by débridement is still of prime importance.

All these statements seek to stress the fact that ancient surgical axioms still dominate despite exaggerated claims to the contrary on behalf of radical technic, new gadgets, sovereign drugs or changed procedure.

Real advance has been made in traumatology since the last war, and in the first rank I would place the awakening of the profession to the importance of placing injuries in the "treat-them-now" class. A broken bone should become just as much an emergency as a ruptured appendix.

Second in importance, and a corollary of the preceding, is the recognition of the time element; trauma has no incubation period.

Third is the factor of added experience by a greater number of qualified surgeons. In the last war, Surgeon General Ireland truly stated that he had hundreds of surgeons in the Reserve Corps capable of performing a gastroenterostomy, but only a few equally proficient in the management of a compound fracture of the femur. In this war, débridement, chemotherapy and antitoxins will play important rôles. Blood and plasma banks will be more accessible and more effectively used. Intravenous anesthesia will become time-saving, pain-saving and life-saving.

But with all the added advantages in the recognition and treatment of the injured, reliance must still be placed on the fundamentals of surgery, neglect of which will give the victory to one of the Four Horsemen of Trauma: death, disability, deformity and despair.

Let us not forget the lessons of the past in preparing for the future; and let us use the present for reviewing and perfecting the devices of general surgery applicable to traumatic surgery in civil or military zones.

"If every man would mend a man, then all the world were mended."

John J. Moorhead

Original Articles

CONSERVATISM IN GASTRIC SURGERY*

A NEW TECHNIC FOR RESECTION

JOSEPH L. DE COURCY, M.D.
CINCINNATI, OHIO

THE history of gastric operations is similar to that of many other phases in the progress of surgery. Working at first with the exercise of extreme caution, operators gradually grew bolder until radical resection became the rule rather than the exception. The number of operations performed greatly increased. So did the mortality rate.

In preparing a paper published over a year ago,[1] I had occasion to look up the prevailing mortality rates in large clinics where special attention is given to gastric and intestinal surgery. I found that they ran from 15 to 27 per cent. In routine hospital operations where gastric surgery is in the hands of general surgeons who do not intervene upon the stomach very often, the rate rises to 47 per cent or even higher.

This is an alarming situation demanding serious consideration and a determined attempt to reduce these distressing high averages. That a widespread effort is being made in surgical centers is evidenced by many signs. A plea for conservatism in surgery of the stomach made in the paper just mentioned, wherein I particularly emphasized the value of the two-stage procedure, has been widely read and commented upon. So many reprints have been requested that my supply was soon exhausted.

These evidences of approval are personally gratifying, but far more important is the interest in conservative gastric surgery and the trend away from radicalism displayed in recent papers (Graham,[2] Chaton and Stern,[3] Cutler,[4] Means,[5] Cutler and Zollinger[6]).

In a well thought out article on the surgical treatment of duodenal ulcer, Castleton[7] discusses conservatism versus radical surgery and remarks on the difference of attitude displayed by surgeons upon the European continent and those of North America. He says: "Continental surgeons report a much higher incidence of recurrence of ulceration following gastroenterostomy than do most of the surgeons of this country." It has been shown by operators who "studied specimens of stomach and duodenum resected by Walters in cases of duodenal ulcer . . . that whereas ulceration and hemorrhagic forms of gastritis are frequently found associated with duodenal ulcer in central Europe, they are extremely rare in this country. It was also shown that multiple ulcers are more common abroad than here. . . . This being the case it is easy to understand why conservative surgery should give comparatively poor results abroad."

But though continental European surgeons are continuing to employ radical measures in intervening upon the stomach, as far back as 1906 students of anatomy and organic function were calling the attention of surgeons to certain physiological factors whose existence argued against radical resection of the stomach if it could by any means be obviated. Edkins[8] experimented by boiling with water, acid or

* From the Department of Surgery, De Courcy Clinic.

peptone sections of pyloric mucous membrane taken from the lower fifth of the stomach wall. He thus produced a decoction which, when injected into the jugular vein of an experimental animal, brought about secretion of gastric juice. Edkins thus showed that secondary secretion of gastric juice is induced by a chemical mechanism, not by local stimulation of the reflex nervous apparatus of the gastric wall as had formerly been assumed.

The first products of the digestive process serve to set this mechanism in operation. The immediate result of its action upon the mucous membrane is absorption into the blood stream of a hormone which has been named *gastrin*.

This hormone is carried to all the glands of the stomach, its essential rôle being to act as a specific excitant of their secretory activity. Since Edkins made these observations, the presence of gastrin in the mucous membrane of the human stomach has been demonstrated many times. Removal of any considerable amount of the mucosa of the pyloric area must inevitably take away one of the chief factors stimulating the formation of gastric juice. Gastric motility will in turn be lessened and the final functional result of the intervention upon the stomach cannot fail to be disappointing.

Discussing Edkins' observations and their present day application, Rienhoff[9] states that, although we are not sure whether the peristaltic waves of contraction arise independently near the commencement of the pyloric antrum (in the distal four-fifths of the stomach), we are sure (because of fluoroscopic observation) that the lower fifth of the stomach is very much more active than the remainder of the cavity. The surgeon cannot hope to restore normal motor function for his patient if the hormone secreting mucosa of this lowest fifth has been extirpated.

To obviate the difficulties thus created, Rienhoff planned an operative procedure wherein he resects the pyloric antrum or "pacemaker," as he calls it. This partial gastrectomy leaves the major portion of the stomach untraumatized. An anastomosis in front of the colon is then made with a short loop between the stomach and the jejunum.

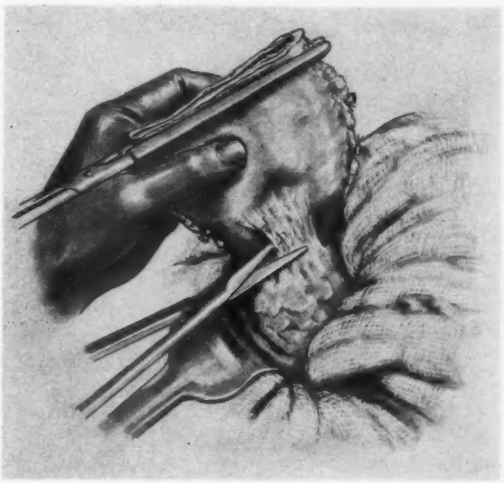

Fig. 1. Cutting the adhesions on the posterior wall of the stomach.

He prefers this short-loop gastrojejunostomy because it is simpler to perform yet apparently just as efficient as the more complicated procedures. With such a short proximal loop in the jejunum, an enteroenterostomy is unnecessary inasmuch as the length of the jejunum from Treitz's ligament to the upper end of the anastomosis is not more than the breadth of three of the surgeon's fingers. Rienhoff claims to have found the results from this procedure to be just as satisfactory as when more radical measures have been undertaken, while the mortality is decidedly less.

FACTORS IN MORTALITY

When we come to examine the causes of death following operations upon the stomach, as recorded in some of the more recent papers upon gastric and duodenal surgery, certain factors stand out with especial prominence. In the hands of a surgeon who is often called upon to intervene upon these regions or confines his efforts exclusively to this type of work, frequently the risk is not greater than in any other abdominal procedure, all other factors being equal. But in the general run of surgical procedures the country over, gastric surgery appears at the

head of the list of poor results. Not only is the mortality directly due to operation very high, but the postoperative morbidity

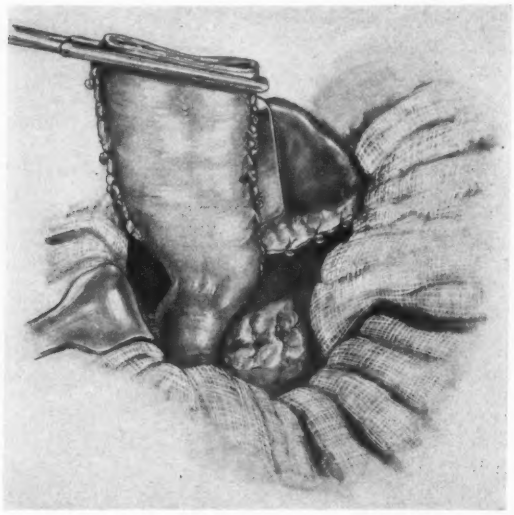

FIG. 2. Stomach held up at end of dissection with slight stretch upon the duodenum.

is much in excess of what it should be and the remote results are often unsatisfactory.

All these factors influence the attitude of the general public toward gastric surgery and make the average individual hesitate when he is informed that his condition requires an operation upon the stomach. This in a measure offsets the improved methods of clinical investigation which enable us to make the diagnosis so much earlier than was possible only a relatively short time ago, thus making the patients come late to operation and thereby preventing the surgeon from obtaining the results he might expect if he were permitted to handle the case more promptly. The vicious circle thus set up is very hard to break and constitutes what in business is called "sales resistance." It proves a very serious obstacle not only to the surgeon's success but to the patient's best interest as well.

TWO-STAGE OPERATION

In an attempt to reduce the mortality, we have at our clinic during several years past treated gastric and duodenal ulcer and cancer patients by a two-stage operation. For pyloric ulcer we first do a gastroenterostomy, followed at the end of several weeks by resection of the ulcerous area. By this method we have found it possible, if necessary, to do a high posterior gastroenterostomy on doubtful or poor risk cases and so improve the patient's general physical condition. Within a short time, in most cases, he is able to withstand the actual removal of the ulcerous or cancerous area, which would undoubtedly have proved fatal if it had been undertaken at the outset.

The two-stage operation thus offers an excellent chance of success in cases in which the more radical procedures would not be feasible. Many patients have been relieved of peptic ulcer or even potential gastric cancer and have survived for years, usually dying in the end from some cause wholly unrelated to the stomach lesion. By doing this operation when the disease is still in a relatively early stage, we are able to conserve the patient's strength and so fit him for the strain of the actual resection. In this way our mortality has been reduced to less than 10 per cent as against the 60 per cent which Billroth sadly admitted in the later years of his professional career.

Lately we have been able to better these figures, for in the five years immediately past we have reduced the mortality in pyloric ulcer cases to less than 4 per cent. Proper postoperative attention will prevent recurrence in the form of gastrojejunal ulcer, which occurs much more frequently than published statistics would lead one to suppose. The surgeon should not consider his responsibility over when the patient leaves the operating room. On the contrary, ulcer of the stomach or duodenum must be looked upon as something more than a surgical problem. Only by carefully thought out co-operation between operator and internist can such postoperative care be efficiently administered.

If the internist has done his duty, the patient coming to operation will already have had a thorough physical overhauling; but it is surprising how often the surgeon finds that such precautions *before* operation

have not been considered necessary. Therefore, if existing foci of infection (such as teeth with apical ulcers, infected tonsils, diseased sinuses or gallbladders which have "given trouble" for long periods) have not been eliminated, it becomes the surgeon's duty to insist upon their prompt eradication.

The patient's habits should be a matter for thoughtful scrutiny. He should be taught the proper hygiene of the mouth—a matter surprisingly neglected even among the better class of patients. His diet should be investigated and a proper regimen laid out for him, if his eating habits are found to be contributing to the gastroduodenal condition. Patients with ulcers will usually have been upon a long course of "ulcer diet" previous to operation. This is by no means an ideal preparation for an exhausting surgical intervention; yet food restriction is, of course, absolutely essential in most of the cases. The immediate postoperative diet should, however, be modified as soon as possible, although such modification must be gradual and its effect upon the patient's general well being carefully checked at frequent intervals.

It has been the experience of our clinic that patients suffering from ulcers, quite as much as those suffering from diffuse toxic goiter, need psychological supervision as well as attention to their physical requirements. Not only should they have plenty of rest and careful avoidance of fatigue in any form, but they should also be freed from worry and excitement and urged to relax and enjoy life. It is frequently most difficult to effect such a regimen, for during the past few years few indeed have been the patients whose lives were not overshadowed by material cares—all too often by the shadow of actual want and privation. But the methods employed in our goiter work have served us well in ulcer cases and the importance of the mental, as opposed to the physical, disturbance which the sufferer from gastric lesions endures is recognized as being nearly equal to the physical handicaps.

In recommending the two-stage procedure, we do not wish to be understood as regarding it as universally applicable. When the patient is in good physical condition and not too greatly depleted as a result of his gastric lesion, so that he is considered a "good risk," the gastroenterostomy and the stomach resection can be carried out at a single session. If a high posterior gastroenterostomy is not considered desirable, we have substituted a high anterior loop anastomosis. We have also found that such an anastomosis need not necessarily be at the extreme distal portion of the stomach. In a number of patients in whom the anastomosis was made upon the high posterior wall, the stomach rapidly accommodated itself to the new arrangement and normal muscular movements were rapidly resumed, so that no gastric stasis occurred.

The resection of peptic ulcer is by no means so extensive an intervention as that required when one must deal with a malignant growth. Because glandular involvement is almost sure to be extensive, a far wider resection is imperative in cases of cancer. We must remove not only the malignant area in its entirety but also the zone of potential malignancy which surrounds it. Under such conditions we usually make a posterior anastomosis; but if circumstances seem to warrant it, an anastomosis in front of the colon may be substituted with safety. No hard and fast rule can be laid down. The surgeon must use his best judgment according to the requirements of the individual case.

The advantages of the two-stage procedure in cases of carcinoma of the pyloric end of the stomach in greatly depleted patients should be especially stressed. Another advantage of the high gastric resection in two stages in cases of gastric cancer has been pointed out by Wangensteen,[11] who noted that it obviates retraction of the esophagus, so often a troublesome feature of the single-stage intervention. This operator also believes that there is much less danger of contamination

when the preliminary gastroenterostomy is employed.

In cases of ulcer there is always the possibility that resection may be avoided altogether when a supposedly preliminary gastroenterostomy is done. The ulcer will sometimes heal completely when the irritation of the passage of material impregnated with the digestive juices is eliminated. Schachner[12] has reported from the Mayo Clinic that 8,600 gastroenterostomies have been done, in many of which subsequent gastric resection was found to be unnecessary. In some instances the enterostomy and resection were carried out at one session. In general, however, the methods at this clinic are conservative; yet they report 90 per cent of cures in gastric ulcer and even lower mortality when the ulcer is located in the duodenum. Such results certainly point to the wisdom of less radical methods.

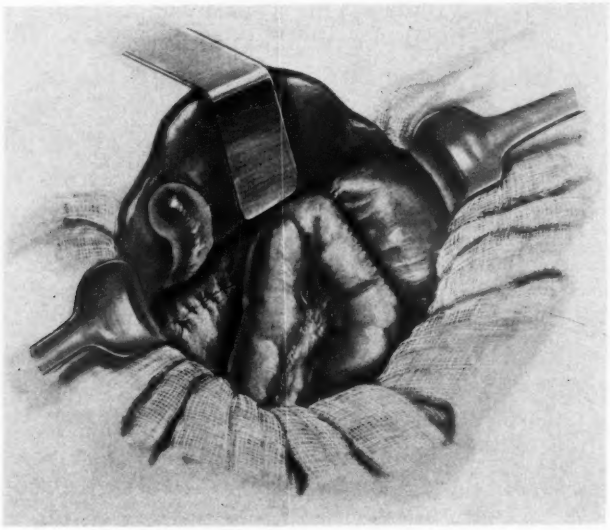

FIG. 3. Operation completed.

TECHNIC

After many years of experience and considerable cautious experimentation, we believe that we have now achieved a technic of stomach resection which, though much simpler than the methods formerly employed, gives us less difficulty as to both immediate and remote complications.

We now begin our resection at the upper or proximal portion of the stomach, so that the area to be excised is removed from above downward. When following this procedure it is possible for us to visualize the posterior gastric wall all the time the resection is being done. This ability to visualize the entire field and even beyond it is a decided advantage, because one is much less likely to injure the pancreas or (in cases in which posterior adhesions have formed) to encounter troublesome hemorrhage.

As soon as the resection has been carried out to the desired limits, the proximal portion of the gastric wall is covered with a heated pad. The distal end is then raised, permitting the clamping and division of the gastrocolic and gastrohepatic omentum, which are carried out as the descent is accomplished. The posterior wall of the stomach is kept under constant supervision, a sharp lookout being maintained for any posterior adhesions. If adhesions are in evidence, they are divided as far down as the attachment of the pancreas to the duodenum. When this point is attained, it will be found an easy matter to strip off the attachment to the duodenum as far as may appear to be necessary. The duodenal arteries are divided and ligated, all hemostats are then tied and the duodenum is divided in the surgeon's usual manner.

Following this procedure, we carry out an anastomosis between the jejunum and

the stomach. As far as the writer is aware, this particular method has never before been described in print. It has the advantages of speed, accuracy and simplicity. In our hands it has proved preferable to the older methods we formerly employed.

CONCLUSIONS

1. Radical gastric surgery carries a high mortality. The history of gastric operations shows that there was at first a gradual advance from conservatism to more radical procedures, but that at the present time there is a decided trend away from radicalism and a very general tendency to revert to the earlier attitude in the hope that the death rate and postoperative morbidity may be lowered.

2. The poorest results are seen in the figures of general surgeons who do gastric surgery only occasionally and thus have no opportunity to acquire the skill and develop the judgment necessary for this work.

3. Careful preoperative check-ups on the patient's physical condition do much to lower the risks. Attention to diet and general hygiene after the operation will shorten convalescence, reduce morbidity and lower postoperative mortality.

4. The two-stage operation, consisting of gastroenterostomy followed after an interval by resection of the ulcerous or cancerous area, may be used with safety on patients too debilitated to withstand the complete operation at one session. In many cases of ulcer the preliminary gastroenterostomy has resulted in cure without the necessity of a subsequent resection. In those cases in which resection is essential, it can be carried out as a second stage without danger even when the patient is much debilitated at the outset, because the gastroenterostomy so greatly improves the patient's nutrition and general well-being.

5. The author has developed a new and simplified technic for performance of the one- or two-stage intervention which he believes has never before been published. It has proved in his hands to be a distinct improvement over methods previously employed in his clinic, both in immediate and remote results.

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THE DISTRIBUTION OF ANESTHESIA FOLLOWING BLOCK OF THE SACRAL NERVES

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LEAVENWORTH, KANSAS

CAUDAL and sacral block procedures have been found to give reliable and safe anesthesia. Yet, despite their frequent use, an important question concerning them has not been settled to the satisfaction of many. This concerns the indication, if any, for the choice of one procedure over the other.

At this institution the two procedures, from the practical viewpoint of producing anesthesia for the common rectal and perineal operations, are found to be interchangeable. Others hold that sacral block provides the only consistently satisfactory result. We are using our material, which in the past has averaged over 200 cases annually, to establish more definitely the relative merits of the two procedures. In a report in preparation the two procedures will be compared and contrasted in many ways.

Before proceeding with comparisons of the two blocks, a more fundamental subject had to be settled. This concerned the exact nature of the anesthesia on the trunk and lower limb that should be expected to follow interruption of sensory conduction at the posterior roots of the sacral nerves. This differs from a description of the anesthesia that follows the clinical procedures of sacral and caudal block. The former area represents a standard from which the clinical effect produced by the block procedures may be judged. We have been unable to find an attempt at an exact deliniation in reading a considerable part of the large literature.

The knowledge necessary to outline these areas has been available since the publication of Foerster's work on the dermatomes of the human body.[1] This work, as well as certain theoretical anatomical considerations, and clinical observations on sensory areas following block procedures have been brought together as the subject of this paper.

ANATOMICAL FACTORS CONCERNING THE SACRAL NERVES

A. Caudal and Sacral Block Distinguished by Example. Reference is made to caudal block and sacral block throughout. It becomes necessary then to emphasize that the technic of caudal block when performed alone differs from that done as part of the complete sacral block. More of the anesthetic solution is used and more time is taken for the injection.

The difference is brought out by the following example: Using 1 per cent of metycaine 60 to 70 cm. of solution are used in either procedure. In the sacral block, 25 to 30 cm. are injected into the caudal space; the remainder is divided for injection into the sacral foramina. In the simple caudal block the entire amount is injected slowly through the one puncture into the sacral canal. The needle is left in place and the injections continued until skin tests show that anesthesia in the desired area is present. This injection is deliberately prolonged over a period of twenty minutes to avoid a drug reaction.

The practical observation may be added here that saving time is not one of the advantages of the simplified caudal block over sacral block procedure. The recurring temptation it presents to attempt to do so during a crowded morning is its worst disadvantage.

B. Site of Block. Anatomical peculiarities of the tissues surrounding the sacral nerves have an important relationship to the block that results after injection is made by the caudal or transsacral route.

In each procedure the injected anesthetic drug acts upon the sacral nerves at approximately the same place. Yet the slight difference in the site of action is of considerable importance. In the caudal block the needle is advanced upward in the sacral canal and the solution is deposited around the termination of the dural sac. This is a true epidural injection. From there the solution disseminates outward along the nerves to and through the sacral foramina. It thus acts on the sacral nerves at the same place that direct injections through the sacral foramina would make contact with them, and probably over a considerably greater length of the nerve as well. There is evidence, however, that the anesthetic acts on the nerve only distal to any prolongation of the dural covering.[2]

By the time an individual sacral nerve comes to lie in its anterior and posterior foramina it has undergone its first subdivision into anterior and posterior rami. These subdivisions only are directly injected by the transsacral approach. The undivided sacral nerve and the ganglion of its posterior root lie within the sacrum where they are reached only by solutions diffusing through the epidural space. The sacral nerves and the rudimentary coccygeal nerves differ from all other spinal nerves (excluding the peculiarities of the first two cervical nerves) in that their ganglia do not lie within the intervertebral foramina.

C. The Relative Importance of Anterior and Posterior Rami of Sacral Nerves. Though the openings of both the anterior and posterior sacral foramina may frequently be pierced by a single injection and the needle point thus brought anterior to the sacrum or even within the pelvic cavity, this is not always so. The sacral foramina are not simple openings lying directly opposite each other on either side of the sacrum. The corresponding anterior and posterior foramina are anatomically described as openings at the lateral ends of a V-shaped canal. This canal is open medially, continuous with the sacral canal, and transmits the anterior and posterior rami of the sacral nerves to the openings of the foramina.

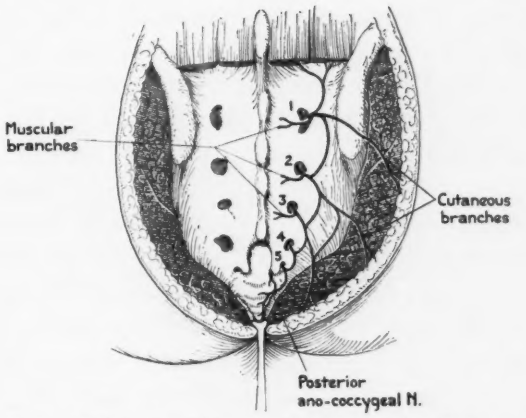

Fig. 1. The posterior sacral plexus. Simple loop connections exist between the nerves. Medial (muscular) branches supply the multifidus. Lateral (cutaneous) branches pierce the gluteus maximus and supply a limited area of integument. The posterior anococcygeal nerve formed by S 4 and 5 and Co 1, is cutaneous in distribution and supplies the skin at the dorsal aspect of the coccyx.

This arrangement has a bearing on the development of anesthesia after transsacral injection. It is the anterior rami that must be blocked for successful sensory anesthesia and muscular relaxation.

The relative unimportance of the nerves emerging from the posterior foramina is surprising on first consideration as the entire attention of the operator is centered on entering these foramina to produce transsacral block. Yet the posterior rami form a simple, looped plexus for innervating a relatively unimportant sensory area over the dorsocaudal region of the trunk and the buttocks. (Fig. 1.) The plexus supplies muscular branches to the multifidus and, joining at the lower end of the sacrum with the first coccygeal nerve, forms the posterior anococcygeal nerve. This is the rudimentary superior caudal trunk of tailed animals and supplies the skin over the dorsal aspect of the coccyx.

On the other hand, the ventral aspect of the coccyx and part of the region between it and the posterior border of the anus is supplied by the anterior anococcygeal nerve. This nerve is formed from the anterior rami of the lower two sacral nerves emerging from the anterior surface of the sacrum, and the coccygeal nerve. It is the rudimentary, inferior caudal trunk of tailed animals. Thus in the area extending from the ventral aspect of the coccyx forward, including the integument between the coccyx and posterior border of the anus, anal margin and all important muscles, the nerve supply, both cutaneous and muscular, stems from the anterior rami of the sacral nerves.

D. The Relationship to the Epidural Space. The sacral canal is part of the epidural space which runs the length of the vertebral column. Injections into it of anesthetic drugs during the performance of caudal block are capable of blocking not only the sacral nerves but also nerves coming off from any level of the spinal dural sac, depending upon the extent of the upward diffusion.

Upward diffusion in effective concentration is usually not extensive and only occasionally produces anesthesia as high as the inguinal region or, as in one of our cases, to the nipple line. This fails to occur regularly to an appreciable extent because lateral diffusion through the foramina of the sacrum presents less resistance.

Diffusion outward along the nerve trunks from the epidural space has been shown to progress freely both by the method of dissection following dye injection as well as by radiographic study after the injection of opaque material. In general, the dye solutions show a greater tendency for upward diffusion. They are found readily in the high cervical and thoracic regions, following injection of 30 cm. into the sacral and caudal space.[3,4] On the other hand, opaque material traced by roentgenograms on living subjects[5] and on cadavers[2,6] shows a greater tendency toward lateral diffusion along the nerve trunks.

Understanding of the behavior of solutions injected into the epidural space is aided by a brief consideration of the dura mater. The cranial and spinal dura, though continuous at the foramen magnum, are quite different. The cranial dura consists of two distinct layers which at certain places enclose the venous blood sinuses. The outer layer is closely attached to the bones of the skull and serves as a periosteal lining. After passing out of the skull and on to the spinal medulla at the foramen magnum, only the inner layer of dura is continued as a covering of the spinal cord. The outer layer of dura is soon dissipated and fails to continue as a lining of the vertebral canal except for a short distance anteriorly. Thus the spinal epidural space lacks an uninterrupted lateral wall. Diffusion of injected material is not greatly impeded in the lateral direction at the intervertebral foramina because the nerves pass through without acquiring a covering from the lateral border of the epidural space.

In considering the dura and epidural space in this light it is interesting that the relatively large veins frequently encountered during injections are in the same morphological plane as the cranial venous blood sinuses.

SENSORY AREAS SUPPLIED BY THE SACRAL NERVES

It is not easy to understand the area of anesthesia which develops in the lower part of the trunk and the limbs following interruption of the posterior roots of the sacral nerves nor can a simplified explanation be devised. In fact, without knowledge of the developmental history of the limbs and caudal region of the trunk, the problem becomes quite unintelligible.

A. Sensory Areas of Lower Part of Trunk. Confusion here is caused by the presence of (1) the small overlapping area of upper lumbar innervation upon the primarily sacrally innervated perineum and (2) in the male by the presence of the testicle, an aberrant viscus which retains at least some

of the innervation characteristic of other intra-abdominal organs.

1. *The Sacral Origin of Perineal Sensory*

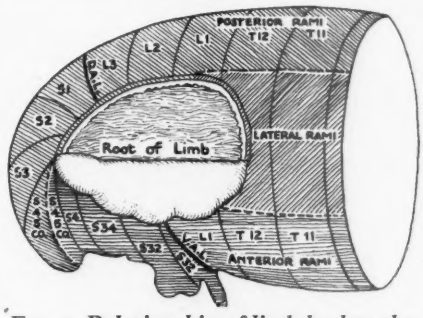

FIG. 2. Relationship of limb bud to the lower myotomes. The perineum develops mostly caudal to the limb. The dorsal (d.a.l.) and ventral (v.a.l.) axial lines are shown at their origins. They extend outward on the limbs and pass between adjacent dermal areas not innervated in numerical sequences. The interruption of segmental innervation at the ventral midline of the lower trunk as a result of the limb development is shown. (After Cunningham.[13])

Innervation. The outgrowth and subsequent development of the lower limb bud from the trunk during embryonic life profoundly alters the segmental arrangement of the lower trunk. In the development of the body, however, the perineum is readily seen to originate caudal to the limb bud. (Fig. 2.) As a result of the developing limb taking a large part of the adjacent nerve supply into its structure, the ventral midline of the body which is ordinarily supplied by the anterior terminal branches of the anterior rami of the segmental nerves, is not reached by these nerves between the segments L 1 and S 2. (Fig. 2.) Yet the ventral axis of the body receives adequate innervation as a result of nerves from the more caudal myotomes below the limb (S 2 through CO 1) reaching to the anterior midline.

In the lower midventral axis of the body then, the structures occurring in sequence are (a) the lower part of the abdominal wall supplied by T 11 and 12, (b) the area of symphysis pubes supplied by T 12 and L 1, and (c) the penis and scrotum (mons and vulva). Part of nerve L 1 (ilio-inguinal) innervates this latter area, but further lumbar elements fail to attain the ventral midline, being drawn into the developing

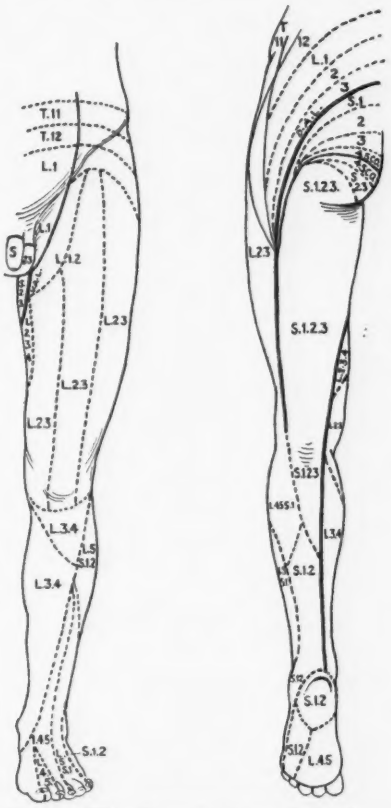

FIG. 3. The dermatomes of the leg outlined by anatomical methods. Areas are smaller than those outlined by "remaining sensibility." Compare L 5 here and in Figure 4. The hypothetical dorsal axial line (which ends near the knee) and ventral axial line are shown. The preaxial (cephalic) border of the limb extends from the middle of the inguinal ligament distally along the line of the great saphenous vein to the medial side of the great toe. The postaxial (caudal) border extends from the coccyx across the medial part of the buttock and down the posteromedial aspect of the thigh to the small saphenous vein. It follows approximately along this structure to the lateral side foot. The sequence of dermatomes can be followed first distally along the pre-axial border then proximally along the postaxial border.

limb. The orderly segmental arrangement of innervation is resumed, however, after the second sacral nerve reaches the ventral

axis at the region where the first lumbar left off.

This numerical gap in innervation, caused by the failure of certain sensory nerves to reach the surface of the trunk, and making for adjacent skin areas innervated from considerably separated cord levels, forms the basis of the hypothetical axial lines (dorsal and ventral). These lines are formed on the trunk and are carried down onto the limbs on dorsal and ventral surfaces. (Figs. 2 and 3.) Together with a knowledge of the embryonic pre-axial and postaxial borders of the limbs (Fig. 3), they give the principal clue of the segmental innervation of skin areas on the limbs (as will be described) and at the limb-trunk borders. Otherwise the arrangement of dermatomes in these areas appears to possess no more order than the covering on a patchwork quilt.

The second and third sacral nerves reach the midline of the trunk below the limb bud and provide the main sensory supply of the genitalia.

(d) The remaining structures of the ventral axis below the scrotum are the central point of the perineum, the anus, ischiorectal fossae and the coccyx. These areas are innervated in an orderly way by the anterior terminal branches of the anterior rami of the lower sacral and coccygeal nerves.

2. *The Innervation of the Testis.* The presence of the testicle within the scrotum further complicates the sensory innervation of the perineum. To the dual (sacral and lumbar) sensory innervation of the scrotum, as previously described, is added a thoracic connection, at least to its underlying structure, the testis. This afferent sympathetic connection originates at the T 10 level and is carried down along with the internal spermatic (testicular) artery as the vessel follows the viscus in its descent.

This triple level, sensory nerve supply of the testis and the overlying scrotum has been established beyond question by the work of Woolard and Carmichael.[7] They performed convincing experiments, using themselves as subjects. Among other things they showed that the pain threshold for the lumbar part of the innervation of the region of the testicle was approximately twice as high as that of the sacral innervation and that the threshold for perception of pain along the thoracic connection was approximately three times as high as for the sacral level. This gives further evidence that the primary source of innervation of these areas is sacral.

3. *Clinical Application.* The material thus far enables us to understand the clinical applicability of block of the sacral nerves for anesthesia of the lower trunk. For instance, circumcision in the adult is readily performed. An operation at the base of the penis such as correction of hypospadias might be unsuccessful. For operations involving the scrotum or testicle additional block of the genitofemoral, ilioinguinal nerves, or fibers accompanying the testicular artery might be necessary. All other structures at the caudal end of the trunk are readily rendered insensible by sacral nerve block and the muscles of the perineum, including the important levator ani and anal sphincter, are deprived of tone.

The anesthesia developing after sacral and caudal block is particularly suited for performing the operation of circumcision on the adult. The dual innervation at the base, of greater theoretical than practical importance, does not interfere with the anesthesia of the operative field. Furthermore, the block usually inhibits the ability to produce erection for many days. This result is probably related to a temporary nerve injury resulting from trauma by the needle at the site of the sacral autonomic outflow (anterior ramus S 2–3), and although subject to an unfavorable interpretation, produces a fortunate temporary result.

B. Sensory Areas of Leg. This subject is difficult to describe and understand because of (1) the loss of an obvious segmental arrangement of the dermatomes of the leg[8] and (2) the marked overlap of one

dermatome into the area of two or three adjacent ones. In this condensed presentation extensive elisions are necessary.

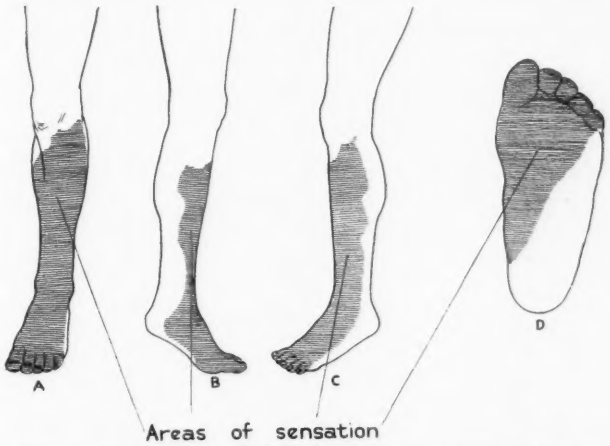

FIG. 4. Full extent of fifth lumbar dermatome. (After Foerster.) The remainder of the leg, except the area of anesthesia shown in Figure 5, is supplied by other lumbar nerves. Impaired sensation in the L 5 area is positive evidence of effective cephalad diffusion in the epidural space. Marked areas in Figures 4, 5, 6 and 7 show tactile sensibility rather than pain sensibility. This makes fields slightly larger when areas of remaining sensation are shown and slightly smaller when areas of anesthesia are outlined.

1. *Segmental Arrangement of Dermal Innervation on the Limb.* The orderly segmental arrangement of the myotomes concerned with the development of the limbs is probably preserved within the limbs only in the arrangement of the somatic nerves and then in a manner far from obvious. As these nerves grow into the limb they maintain a fairly orderly succession along the pre-axial and postaxial borders. The higher nerves, after division into anterior and posterior trunks, supply the pre-axial border of the respective anterior and posterior surfaces of the limb in numerical sequence from the proximal to the distal border. The numerical sequence is maintained along the distal border of the limb toward the postaxial border, and then along the postaxial border from the distal to the proximal end. The lowest nerves entering the limb, for example, supply the most proximal part of the limb along the upper part of the postaxial border. (Fig. 3.) It is thus seen that a simple arrangement, whereby the higher nerves would supply the proximal part of the extremity and the lower nerves the distal part, does not prevail.

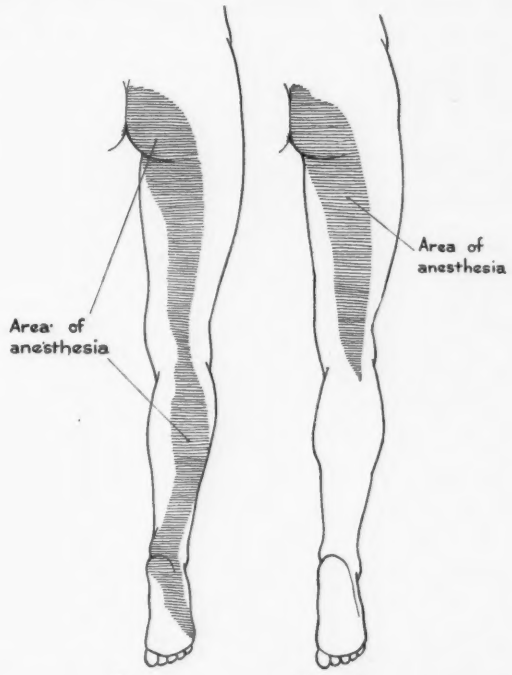

FIG. 5. FIG. 6.

FIG. 5. The area of anesthesia on the thigh and leg following interruption of all five posterior sacral roots. (According to Foerster.)

FIG. 6. The complete area of anesthesia on the lower extremity following interruption of the posterior nerve roots of S 2 and 5. The usual clinical block aims at blocking the anterior and posterior rami of these nerves.

Understanding the sensory areas on the leg is complicated further by the fact that the pre-axial and postaxial borders (these terms mean simply the proximal and distal borders of the embryonic limb bud and their subsequent development) achieve a much altered position in the adult from the simple arrangement existing in the fetus. This occurs through the rotation of the limb in development, and is compounded by the fact that the upper limb and the lower limb on each side rotate in opposite directions. In the lower limb the embryonic ventral surface becomes practically the mature dorsal surface.

In the preceding discussion of the perineum the origin of the hypothetical dorsal and ventral axial lines was mentioned. (Figs. 2 and 3.) It was related to the failure

of certain of the centrally placed nerves entering the root of the limb to attain the surface of the limb, (in the former instance the surface of the trunk) leaving a line They are shown to follow a roughly circumferential course about the limb from the upper pre-axial to the upper postaxial borders.

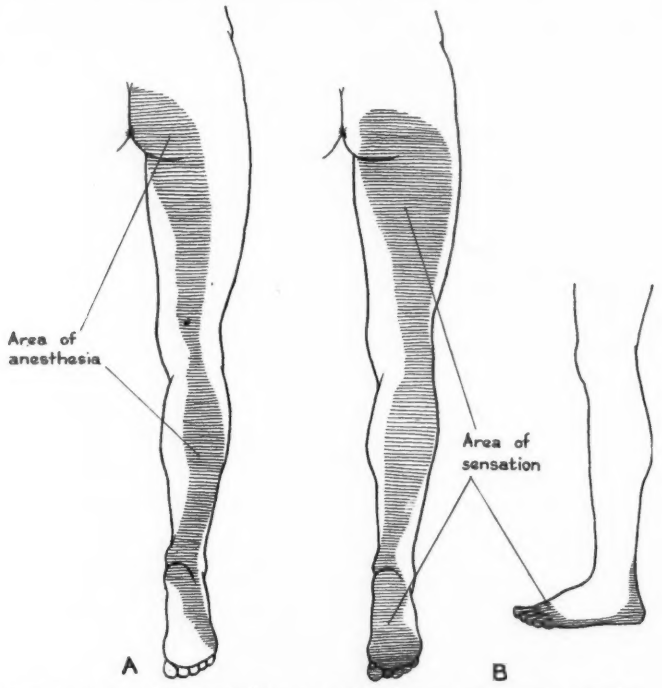

FIG. 7. Area of insensibility (A) after interruption of posterior roots of all five sacral nerves contrasted with area of remaining sensibility (B) of a single one of them, S 2. The former is smaller. Small differences exist at the proximal and distal ends of the fields shown. (According to Foerster.)

along the approximate midpart of each embryonic ventral and dorsal surface where adjacent areas of the skin are innervated by nerves not in strict numerical sequence. (Figs. 2 and 3.)

After consideration of the pre-axial and postaxial borders of the limbs (described in the legend to Figure 3) and the hypothetical dorsal and ventral axial lines (Figs. 2 and 3), we are in a position to interpret the usual picture of the dermatomes as given in most treatises on anatomy and to appreciate the recondite, nevertheless orderly, arrangement that is preserved. These pictures, such as Figure 3, present the outlines of dermatomes as worked out originally by Head[9,10] before 1893 and subsequently modified by anatomical methods.

The area marked as belonging to an individual dermatome represents the approximate central part of each dermatome.

2. *The Overlap of Dermatomes.* As the area of sensation referred into the cord through each spinal nerve is actually much larger than shown, these outlines have little practical value.

However, considerable exact knowledge concerning the dermal areas on the lower limb does exist as the result of the work of Foerster.[1] He has had the opportunity of defining almost every dermatome on human subjects by Sherrington's method of remaining sensibility.[8,11] This term refers to the area of sensation left after division of the three posterior roots above and below the one being studied. (In sacral anesthesia it is not the posterior roots but the combined anterior and posterior rami that are blocked.)

Foerster's method obviously gives the full extent of each dermatome including the overlap onto the adjacent ones.

Using these enlarged outlines of dermatomes, certain figures can be prepared for showing the exact area of sensation loss on the leg to be expected following interruption of the posterior sacral roots. The efficiency of anesthetic blocks may be determined by comparison.

The significance of these areas (Figs. 4, 5, 6 and 7) in relation to clinical block procedures is given in the legends to the figures and in the discussion.

DISCUSSION

There is no loss of sensation in a given spot on the skin where complete sensory nerve interruption to two of the three dermatomes supplying the area has occurred but where the nerve supply to a third dermatome remains intact. More than this, several investigators have shown on animals and Foerster[12] has shown on human subjects, that the entire dermatome is represented in every filament of the posterior root. If one filament remains intact, no anesthesia develops in the entire dermatome.

This fact helps to explain the difficulty and uncertainty in producing block anesthesia which depends for its successful accomplishment on diffusion over considerable distance after the injection has been made. Brachial plexus block, or else the type of epidural block under consideration here, when deliberate upward diffusion for high anesthesia is sought, present examples of this difficulty.

By making use of exact dermal areas of innervation the one practical means of tracing effective upward diffusion in the epidural space following caudal and transsacral block is available. Other methods that have been used have limitations. Dye injections are of academic interest only. Contrast media show the physical progress of the diffusion without establishing whether the quantity is effective in producing anesthesia. On the other hand the area of anesthesia achieved, provided interpretation of its relationship to the cord level is available, localizes exactly the extent of effective diffusion.

As effective diffusion progresses upward in the epidural space, the course should be shown by sensory changes on the limb. From a small area on the back of the thigh, showing involvement of S 2–S 5 (Fig. 6), anesthesia should progress to the back of the leg and heel, showing involvement of S 1 (Fig. 5), thence to the great toe (L 4 through S 5), and the knee (L 2 through S 5).

The actual development of anesthesia on the leg after clinical block of the lower four sacral nerves closely follows the pattern indicated by accurately limited posterior root sections. However, the progress of the anesthesia is often irregular and subject to the changes of intensity over many minutes. The anesthesia spreads from the anal margin distally, along the medial aspect of the buttock, toward the center of the posterior surface of the thigh, stopping well above the leg. (Fig. 6.) Frequently, however, full sensibility is preserved in this area after the sphincter has completely relaxed. This condition is usually followed by loss of pain and finally by tactile sensibility on the area as shown.

Ten minutes later and even longer, the heel becomes insensitive. (Fig. 5.) This indicates positive cephalad diffusion in the epidural space. The first sacral nerve, which must be blocked to produce anesthesia of the heel, comes off at a level definitely beyond the immediate vicinity of the extremity of the needle used for injection.

In the areas that positively depend upon effective diffusion for the development of anesthesia, touch sensibility is preserved long after pain sensibility has gone. On pinpoint testing the lightest touch is appreciated immediately. This condition prevails for many minutes. At first it prevented realization of the fact that sensory changes were taking place. Later it was found that a sterile needle could be skewered through the skin where tactile sensibility remained without causing pain perception. Finally, complete loss of sensation develops.

In Foerster's work with sectioned posterior roots the area of remaining sensibility was found to be larger for touch sensibility than for pain. From the above observation apparently the tactile fibers, beside covering a larger area than pain fibers, resist, to a greater extent, the action of anesthetic drugs.

When large quantities (100 cc. of a 1 per cent solution of metycaine) are given slowly, diffusion progresses for as long as forty-five minutes. At the completion of a rectal operation, for instance, the great toe and even the entire lumbar innervated area on the anterior surface of the leg and thigh, may have lost pain sensibility, whereas it preserved full sensation before the operation was started.

The higher lumbar areas, when affected at all, seem to give up sensation simultaneously as though upward diffusion had occurred over a considerable area rapidly, but effective penetration of the nerves by the solution had been delayed. Usually only pain sensibility is lost at these higher levels.

These effects on the lumbar nerves usually follow the use of caudal block alone and in the relatively large quantities mentioned. After smaller amounts in both caudal and sacral block frequently nothing but loss of pain sensibility with tactile sensibility preserved is found on the legs in the region indicated in Figure 6.

CONCLUSIONS

Anatomical material, related both to the development and ramification of the sacral nerves and the anesthesia that should be expected after these nerves are interrupted, has been brought together. The areas of anesthesia to be expected on the caudal part of the trunk and on the lower extremity have been described.

Clinical evidence of the course of effective upward diffusion of anesthetic solutions injected into the epidural space has been presented. As higher nerves become involved the area of sensation loss on the leg shows an orderly progression. It passes from the back of the thigh downward to the back of the leg and heel, thence to the big toe, upward to the anterior surface of the knee and finally reaches the inguinal region.

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AN ANALYSIS OF 151 CASES OF INTUSSUSCEPTION FROM CHARITY HOSPITAL OF LOUISIANA AT NEW ORLEANS*

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NEW ORLEANS, LOUISIANA

THE subject of intussusception in infancy and childhood was so comprehensively discussed by Ladd and Gross[1] in 1934 that an extended review of the literature would not be necessary or even justified at this time. On the other hand, although their analysis of 372 cases is one of the largest collected series on record, analyses of similar series continue to be justified, for the mortality of the condition, except in the hands of occasional surgeons who have personally seen large series, continues to be unduly high.

During the thirty-four-year period ending in 1938, 151 patients with intussusception were treated at Charity Hospital of Louisiana in New Orleans, twenty-one in the first decade, thirty-three in the second, seventy in the third and twenty-seven in the last four years. Since many of the cases in the first years were diagnosed only at autopsy, it may be assumed that many other cases were overlooked during that period, and the increasing incidence, as the study progresses, is perhaps largely apparent. On the other hand, the unevenness of the recent incidence is difficult to explain. There seems no reason why eleven cases should have been observed in 1933 and twelve in 1937 against three in 1935 and five in 1938.

RACE, SEX AND AGE INCIDENCE

In the 148 cases of this series in which the race was stated, eighty patients were white and sixty-eight negro. This is a relative incidence of 54:46, which is approximately the white-negro incidence of admissions in an average year at the New Orleans Charity Hospital.

The sex incidence is essentially the same as reported in other series, ninety-eight of the 151 cases occurring in males, against fifty-three in females. This proportion, 64:36, is approximately the same as that reported by Ladd and Gross, Hipsley,[2] McLaughlin,[3] and Miller and Workman.[4] Almost the only series in which the female incidence is even slightly greater than the male is that of Davis,[5] which consists of only twenty-two cases.

In the Charity Hospital series eighty-eight cases (59.5 per cent) occurred in children under two years of age, thirty-two cases (21.6 per cent) in individuals between two and fifteen years of age, and twenty-eight cases (18.9 per cent) in individuals sixteen years of age or older. The age was not stated in three cases. The upper and lower age limits were two months and sixty-three years.

Fifty-one patients under two years of age were white and thirty-six negro; from two to fifteen years of age, nineteen were white and fourteen negro; over fifteen years of age, ten were white and eighteen negro. The incidence of the adult type of intussusception is thus somewhat greater in the colored race, though the ratio is reversed in the infantile group. The differences are too small to permit conclusions, especially as the literature contains practically no data on the racial aspects of intussusception.

Intussusception is predominantly a disease of extreme youth. Of the eighty-eight cases in this series, representing consider-

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ably more than half of the whole group, which occurred in children under two years of age, seventy-three, roughly 83 per cent of this group and almost 50 per cent of the whole group, occurred in children under one year of age. Furthermore, forty-one cases, roughly 56 per cent of the group under one year of age and roughly 28 per cent of the whole series, occurred in the fifth, sixth and seventh months of life.

These figures parallel those reported in the literature. Eighty-seven per cent of Ladd and Gross' cases occurred under two years of age, and 70 per cent in infants between four and eleven months. Mayo and Phillips[6] reported 80 per cent, Perrin and Lindsay[7] 78.5 per cent, Rosenblum[8] 75 per cent, Davis 59 per cent, Miller and Workman 54 per cent, and Straus[9] 60 per cent in the same age period. Only five cases in the Charity Hospital series occurred in infants under twelve weeks of age, and it is generally agreed that intussusception is not usual before this time.

ETIOLOGY

An analysis of this series throws no light upon the etiology of intussusception except to make clear again that from this standpoint the infantile and adult types are widely different. In the adult type it is fairly usual and in the infantile type it is definitely unusual to find a causative factor.

In this series Meckel's diverticulum was present in two of the eighty-eight cases in children under two years of age, and in a third a definite mass, probably of neoplastic origin, was observed in the cecum. In the thirty-two cases between two and fifteen years of age, three patients presented Meckel's diverticula, two polyps and one a fibrosarcoma of the intestine. In the twenty-eight cases over fifteen years of age, Meckel's diverticulum was present in one case and neoplastic growths, two of which were malignant, in six others. The relatively high incidence of new growths in the older age groups corroborates the general belief that they are characteristic of adult intussusception. They were observed in 100 of the 300 cases collected by Eliot and Corscaden (cited by Christopher[10]). The infrequency of a causative factor in the infant group, on the other hand, is generally corroborated in the literature; Ladd and Gross found a cause for the accident in only 5 per cent of their cases.

An indefinite or remote cause, such as diarrhea, enteritis, enlarged mesenteric glands, dietary indiscretions, enlarged Peyer's patches, adhesions, constipation, or the taking of a purgative, was present in twenty-two cases, alone or in combination, in the infantile group, in ten cases in the middle group, and in eight cases in the adult group. There is considerable reason, however, to question the cause and effect relationship. Thus diarrhea and constipation are quite as likely to be results as causes of the intussusception, the former early in the process and the latter at a later stage. Rosenblum suggested the marked peristalsis concomitant with diarrhea, which was present in 5 per cent of his cases, as a possible cause. The frequent occurrence of enlarged mesenteric glands and mobile cecums in the infantile group is rather striking, but how such conditions could operate to produce intussusception is not clear.

Dietary errors have been mentioned as a possible cause, particularly among patients of the poorer classes; but Ladd and Gross, whose series includes a large number of private patients, do not consider the suggestion reasonable. Hipsley noted a somewhat higher incidence (158) in the hot months as compared with the cold months (151), and it is striking in our own series that eighty-six cases, well over half of the total number, occurred in the five-month period April to August inclusive, when diarrhea is commonest in children.

None of the other causes suggested, most of which are purely speculative, were observed in the Charity Hospital series, and heredity seemed to play no part. In this connection, one must mention the interesting case reported by Haggard and Floyd,[11]

in which a father and his daughter each had two resections for intussusception, while the son had one disinvagination and three resections for the same condition. Also of interest are the two cases reported by Fiske[12] following prolonged fasting in the observance of Mohammedan religious rites.

CLASSIFICATION

In addition to the obvious division into primary and adult types, intussusception is classified regionally, according to the section of bowel in which it occurs, and also as single or multiple. The common anatomic types are the ileoileal or enteric and the colocolic, which are self-explanatory; the ileocecal, which occurs if the intussuscipiens, when it reaches the ileocecal valve, meets some obstruction and carries the valve ahead with it as the apex of the intussusceptum; and the ileocolic, which occurs when the ileum passes into the large bowel through the ileocecal valve.

As in all series, the ileocecal and ileocolic types were most frequent in the Charity Hospital cases, although most surgeons, unfortunately, made no distinction between them. They accounted for a total of seventy-seven cases, (fifty-two in the infantile, fifteen in the intermediate, and ten in the adult group). The enteric type of intussusception was present in nineteen cases (seven infantile, three intermediate and nine adult), and the colocolic type in eleven (three infantile, five intermediate and three adult). The various types were fairly evenly distributed between colored and white subjects.

Multiple intussusception occurred in three cases, two in the infantile and one in the adult group. In one case three enteric (ileal) invaginations were found, all of which were easily reduced. In a second case seven were found, one of the ileocecal and six of the enteric type; each was about 5 cm. in length, and reduction was easily effected in all. In the third case a colocolic invagination was easily reduced, but the ileocecal invagination also present caused considerably more difficulty. In a fourth case two enteric (jejunal) intussusceptions, about 25 cm. apart, were discovered at autopsy and may have been a postmortem phenomenon. The multiple type of invagination is apparently not very frequent. It was observed in only three of Ladd and Gross' 372 cases, and single cases have recently been reported by Kander,[13] Gill[14] and Papodopoulous.[15]

What seemed to be a double intussusception was found in one case in this series, the ileocolic invagination passing into the descending and sigmoid colon. Another case described as double seems more likely to have been merely of the ileocecal variety. Double invaginations have been reported by Engstad[16] and by Dwan and Wyatt.[17]

Retrograde intussusception occurred in only one case in this series, an infant twenty-one months of age, in whom the lower ileum was found at operation to have invaginated six to seven feet upward into itself. According to Rosenblum, this type occurs most frequently just before or at the time of death. Single cases have been reported by Mitchell,[18] Lewis,[19] Flemming[20] and Ryan.[21]

It is possible, as happened in one case in this series and in one reported by Hipsley, for the ileum to pass through the entire length of large bowel and present at the anus. The colocolic type of intussusception may also present at the anus and on superficial inspection may resemble a prolapse, though differentiation is simple on rectal examination.

One case of intussusception of the cecum in which the appendix was involved is included in this series, and partial appendiceal intussusception is undoubtedly more frequent than the eighty odd cases reported in the literature would seem to indicate. I myself have knowledge of two other cases at Charity Hospital which are not included in this analysis.

It is regrettable that in thirty-nine cases in this series, twenty-seven infantile, six intermediate and six adult, an adequate classification of the intussusception was not possible.

RECURRENT INTUSSUSCEPTION

Recurrent intussusception was actually or presumably present in fourteen cases, three in the infantile, four in the intermediate and seven in the adult type. Since the frequency of intussusception in the three groups was respectively 88, 32, and 28, the distribution of the recurrent cases is significant, and is undoubtedly to be explained by the increased frequency of neoplastic causes in the intermediate and adult groups.

The distribution of the deaths in the recurrent cases is also interesting. One death occurred in the three patients in the infantile group, none in the four cases in the intermediate group, and two in the seven cases in the adult group. An examination of the individual records reveals in several cases in the intermediate and adult groups a history of severe episodes over a period of months, and makes one wonder how the patients escaped with their lives. In several cases in this series, for that matter, symptoms were present over so long a period of time that the condition could probably be classified as chronic. The histories suggested that the invagination had been present one or more times, reducing itself before symptoms were sufficiently acute to force the patient into the hospital and being succeeded by a period of quiescence.

In one of the recurrent cases in the infant group the intussusception either recurred within six hours or reduction at operation was incomplete, for postmortem examination six hours after death showed an intussusception of the entire large intestine. The same question arose in another instance in which death occurred three days after operation.

A possible recurrence was suspected but not proved in two other cases, both in the intermediate group. One patient had a return of symptoms, which disappeared under conservative therapy, within a week after operation. The other, an eight-year-old girl, whose intussusception was reduced surgically, had a clear-cut history of a similar attack, from which she had recovered without operation, at eighteen months of age.

SYMPTOMATOLOGY

An examination of the symptomatology and physical findings in this group of cases revealed a very high correspondence with the classical picture: A perfectly well child, frequently a male under two years of age, had a sudden attack of acute abdominal pain manifested by crying, the assumption of a certain posture, or even the placing of the hands on the presumably painful area. The pain was frequently associated with vomiting and bloody stools. It was the exception rather than the rule to find any mention of emaciation or other signs of previous illness in these children, even those who were gravely ill from the result of their obstruction. Pallor and sweating accompanied the pain in some instances, but the temperature tended to be normal or subnormal and the pulse relatively slow unless shock, dehydration or peritonitis was associated with an obstruction of relatively long duration.

This series emphasizes again the importance of remembering that in the typical case of intussusception symptoms are present only spasmodically, and that the child may seem perfectly well between attacks. In three instances in this series the children were seen in the admitting room between attacks, the gravity of the situation was not realized, probably because the parents' histories were inadequate, as it so often is in individuals of this level of intelligence, and the patients were sent home as not seriously ill. All returned, of course, at a later period and in a far more serious condition. It should also be remembered, in this connection, that although bloody stools are very frequent in intussusception, the first stool is often normal because it consists of fecal matter contained in the rectum.

An abdominal mass, which is part of the typical picture of intussusception, was

present in a large majority of these cases, though in some instances it was identified only by rectal examination or after the patient was under an anesthetic. One of the notable features of the histories was the persistence of the term "sausage-shaped" for the masses over the whole thirty-three years. Whether the resemblance actually impressed the various historians, or was merely handed down, as such terms frequently are, from one generation of medical men to the next, is an interesting source of speculation.

The masses were variously located in the midline, the right and left upper and lower quadrants, the epigastrium, the lower abdomen and the paraumbilical and umbilical regions. Dance's sign, emptiness of the right lower quadrant, was observed in one instance.

DIAGNOSIS

The diagnosis of intussusception was confirmed at operation in 121 of the 151 cases and by autopsy in fifteen others. In three of the latter group the postmortem examination was performed in the coroner's office. In three instances in which operation was not done, diagnosis was made on definite radiologic evidence, and in the remaining twelve nonsurgical cases the history and physical findings were sufficiently definite to leave little doubt as to the correctness of the diagnosis.

Intussusception at Charity Hospital was first diagnosed by *x*-ray accidentally in 1920, in a case in which a KUB film was made. Flat plates were used occasionally thereafter until 1929, when the use of a barium enema for this purpose was first recorded. This method was used in thirty-one of the sixty-five cases observed after 1930. The film was reported negative in three of these cases, and in two others the diagnosis was ovarian cyst and lymphosarcoma. The findings did not differ from those usually reported.

A study of the records makes it clear that radiographic examination with the barium enema was occasionally very useful in diagnosis, though it was unnecessary in the great majority of cases, in which the history and physical findings were typical. Fluoroscopy was sometimes an important aid. Reports in the literature differ as to the value and necessity of this method. Edberg (cited by Rutledge[22]) is more positive than most authors as to its value, asserting that it makes possible differentiation between the rather easily reduced ileocecal obstruction, which can sometimes be treated by conservative hydrostatic methods, and the stubborner ileoileal and colocolic types, in which surgery is practically always necessary.

CONSERVATIVE THERAPY

Conservative therapy was not used deliberately in any case in this series. The Charity Hospital surgeons seem to share the general opinion that gambling on so remote a possibility as spontaneous cure can scarcely be described as a method of treatment. The type of case in which the intussuscipiens sloughs out after its blood supply is damaged, and intestinal continuity is later restored by natural processes (Bockhoven[23]), does not seem to be included in the Charity Hospital series.

Although the method was not deliberately employed in any case in this series, reduction of the invagination by hydrostatic pressure has been so very successful in the hands of Hipsley that it cannot be ignored. The method, as he used it, seems both safe and successful, and the number of accidental reductions reported after barium enemas makes it seem perfectly logical. It will have to be used more widely, however, before generalizations concerning it are possible.

SURGICAL THERAPY

Surgery was employed in 121 cases in the Charity Hospital series, in 116 of which it was possible to determine exactly what was done. The general plan seems to have been to regard intussusception as a strictly surgical condition and to resort to operation as soon as the diagnosis was made. The

cases handled in the later years of this study were almost invariably treated in this manner unless the patient refused surgery.

Reduction was accomplished by simply milking back the intussusception in eighty-three of the 116 cases (68.6 per cent) with a mortality of thirty-two cases, 38.5 per cent. Some degree of traction was usually necessary and warm packs were usually applied. Ladd and Gross used this method in 83 per cent (308) of their 372 cases, with a mortality of 27 per cent for the first twenty years and of 12 per cent in the last five years. The discrepancy between their series and ours is somewhat less than it seems because their series includes a fairly large number of private patients, the mortality of whom in acute conditions is usually less than that of ward patients.

Incision of the cuff was used in two cases, and two others were treated by anastomosis around the mass, leaving the intussusception to slough out. All four patients died, one child dying on the table before the operation was complete.

Resection was done in twenty-seven cases, the type undoubtedly playing an important part in the mortality rate. In this series fifteen resections followed by anastomosis resulted in nine deaths, two of which occurred in the seven end-to-end anastomoses and four in the seven side-to-side anastomoses. There were four deaths in the seven resections in which the type of anastomosis could not be determined. These figures leave no doubt that anastomosis in the presence of intussusception carries as high a death rate as it does in any other type of intestinal obstruction.

Counting all operative cases, enterostomy was performed eleven times, twice after reduction, with recovery in both instances, and nine times after resection, with five deaths. There was one death in the two resections in which double-barreled enterostomy was performed. The one case in which resection was done as the second stage of exteriorization of the bowel ended in recovery. Woodhall[24] has reported two successful resections by a modification of the usual Mikulicz procedure to include a lateral anastomosis below the openings of the double-barreled enterostomy. He considers that this modification, in addition to guaranteeing the immediate continuity of the lumen of the bowel, is of value in controlling the obstruction due to edema which frequently occurs at the site of the anastomosis, as well as in controlling the fluid loss. In view of the high mortality of immediate anastomosis following resection in cases of obstruction, the double enterostomy would seem, in general, to be a logical procedure.

Six of the resections were performed in infants with six deaths, nine in subjects in the intermediate group with four deaths, and twelve in the adult group, with five deaths. Obviously, the age of the subject is an important consideration in the death rate, and resection in early life is a formidable procedure. The literature bears out our own figures. Woodhall considers that resection in young children carries a mortality of at least 70 per cent, and Ladd and Gross had only two recoveries in thirty resections in this age group.

My personal feeling is that the tendency to perform additional surgery at the time the intussusception is reduced is entirely unwarranted. My experiences as a surgical resident have convinced me of the wisdom of the rule that surgery which is not absolutely necessary is contraindicated in the course of an emergency operation. An analysis of the cases in this series bears out this opinion.

The appendix was removed in forty-three cases, thirteen of which ended fatally. That the additional operative procedure was the cause of the fatality it is not possible to say definitely. It is clear, however, that the condition of the appendix or of its blood supply did not demand the appendectomy in any but a few instances. It is difficult to believe that such a procedure was warranted as was undertaken in one infant five months of age: reduction of the intussusception through a median incision,

followed by appendectomy and cecostomy through a McBurney incision. It is easy to believe, however, that the baby died.

To perform appendectomy in the hope that the resulting adhesions will fix the ileocecal region and prevent recurrence of the intussusception does not seem logical. Of equally questionable wisdom or value is cecopexy or colopexy, which was performed thirty-two times in this series, with fourteen deaths. Recurrence is supposed to ensue in less than 2 per cent of all such cases, which does not warrant the risk of the additional procedure.

Ladd and Gross share my personal opinion as to the folly of additional surgical procedures. In their series the appendix was removed only once in the last five years. They are also opposed to the removal of Meckel's diverticulum. In their series this was done seven times, with five deaths, as against no deaths in the three cases in which a diverticulum was present but was not removed. Meckel's diverticulum was excised twice, with one death, in the Charity Hospital series.

The removal of a tumor which may be responsible for the intussusception is in quite a different category, particularly in adult subjects. Even in such circumstances, however, it is well to defer the procedure until a later date if there is the slightest doubt as to the condition of the patient. The tumor was excised four times in this series, with no fatalities. Enterotomy for the removal of a tumor was performed twice, in patients four and fifty-nine years of age, and resection twice, in patients fourteen and forty-eight years of age.

ANESTHESIA

In adults the choice of anesthesia is largely a matter of the surgeon's preference. I myself prefer spinal anesthesia. In infants the decision is between ether and local anesthesia, Ladd and Gross, as well as McLaughlin, preferring ether.

In this series ether, sometimes with the addition of local analgesia (five cases) or nitrous oxide (one case) was used in sixty-four cases and chloroform in one (a very early case), with a mortality of thirty-three cases, 51.5 per cent. The mortality for ether anesthesia in the infant group was 61 per cent, in the intermediate 30.7 per cent, and in the adult group 36.3 per cent.

Spinal analgesia was used in fourteen cases with one death, 7.1 per cent. Three patients in this group were infants under two years of age, all of whom recovered. Local analgesia was used in twenty-two cases, with thirteen deaths, 59 per cent. Eighteen of this group were infants, thirteen of whom, 66.6 per cent, died. In four cases in which nitrous oxide, with or without local analgesia, was used, there were two deaths, and there were eight deaths in the sixteen cases in which it is not clear what type of anesthesia was used.

INCISION

It is doubtful that there is any direct connection between the type of incision and the mortality of intussusception. In this series the right rectus was used in sixty-six cases with twenty-six deaths, 29.4 per cent; the left rectus in seventeen with eleven deaths, 64.7 per cent; and the median in sixteen, with eight deaths, 50 per cent. The type of incision was not mentioned in twenty-one cases, in which eleven deaths, 52.3 per cent, occurred.

Four eviscerations occurred in this series, in three cases following a right paramedian, a right rectus and a left rectus incision, respectively. In the fourth case it is not clear what type of incision was used. In a fifth case the intussusception itself was discovered after an evisceration following operation for a ruptured appendix.

The fact that the mortality was highest in the cases in which a left rectus approach was used seems to indicate that in these cases the pathology was further advanced; it is known that the mass presents on the left side in the most advanced cases of intussusception. Ladd and Gross, who formerly used a midline incision, have recently expressed a preference for the right paramedian type. Hipsley uses a muscle-

splitting incision if the intussusception has been partially reduced, otherwise a paramedian or midline incision.

POSTOPERATIVE COMPLICATIONS

Shock was the most important postoperative complication in this series. It was undoubtedly responsible for the four deaths which occurred on the table, and undoubtedly played an important part in the thirty-three deaths which occurred within twenty-four hours and the additional thirteen deaths which occurred within forty-eight hours of operation. In other words, in fifty of fifty-seven deaths, 87.7 per cent of the total number, shock played either the major rôle or an important contributory rôle. Toxemia and dehydration were also important. It is interesting to observe, in this connection, that 85 per cent of the deaths in Ladd and Gross' series occurred within forty-eight hours.

In view of the rôle played by shock in the fatal outcome, it is clear that in spite of the urgent need for prompt treatment in these cases, measures to treat shock and correct dehydration should be employed before operation in every severe or long-standing case of intussusception. It is not possible in this series definitely to correlate postoperative treatment and mortality, but there is no doubt that one of the most important considerations in the reduction of mortality observed in recent years has been the improvement in preoperative and postoperative treatment. The maintenance of body heat in infants before and after operation and the return of these children to a full feeding schedule as promptly as possible were also important considerations. The use of parenteral fluids is important in every age group, and particularly important in children and in individuals advanced in years.

Other important complications in the order of frequency included wound infections (sixteen) and pneumonia (seven). There were four eviscerations, as has already been mentioned. Other complications and complicating diseases included malaria, tuberculosis, smallpox, otitis media, convulsions, bronchitis and intestinal parasites. Diarrhea was frequent but was alarming in only one instance.

MORTALITY

Excluding one case, in which the mother removed the child from the hospital as soon as operation was advised, the mortality for the series of 150 cases was seventy-eight, 52 per cent. The surgical mortality was fifty-seven of 121 cases, 47.1 per cent, and has shown a successive improvement as the series progressed. From 1905 through 1916 the surgical mortality was sixteen of twenty cases, 80.0 per cent. From 1917 through 1927 it was twenty-three of forty-two cases, 54.8 per cent. From 1928 through 1938 it was eighteen of fifty-nine cases, 30.5 per cent. This deplorable death rate, which becomes correspondingly higher when the nonsurgical cases are included, is to be compared with the 11 per cent recently reported by Hipsley and the 14 per cent recently reported by Ladd and Gross.

Part of the high mortality at Charity Hospital can be explained by the fact that the series consists entirely of ward patients, whose delay in seeking medical attention corresponded, as always, to their level of intelligence and education. It is a curious fact, however, that the negro mortality, which in most acute diseases at Charity Hospital is higher than the white mortality, in intussusception was actually slightly lower, thirty-four of sixty-eight cases, 50 per cent, as compared with forty-two of eighty white cases, 52.5 per cent.

Excluding the recurrent or chronic cases, in which the long duration of symptoms introduces a factor of confusion, a clear connection is observed between the duration of illness and the mortality, especially when age groups are taken into consideration. In the infant group the mortality was 57.0 per cent when the duration was less than twenty-four hours, 85.7 per cent at the end of twenty-four hours, and 100 per cent over that period. In the intermediate

group there was no mortality when the duration of symptoms was twenty-four hours or less, but a 33.3 per cent mortality at the end of two days, and a 28.5 per cent mortality at the end of three days. In the adult group there was no mortality when the duration of symptoms was forty-eight hours or less, though seven of ten patients died when the duration was seventy-two hours or more. The trend of the mortality rates in relation to age and duration of illness are clear, though only in the infantile group is the number of cases large enough to warrant statistical conclusions.

There is no doubt that the most important factor of mortality is the duration of symptoms before operation. Thus Davis reported a 25 per cent mortality in patients seen under nineteen hours, against 100 per cent in patients seen at the end of twenty-four hours. Thomsen (cited by Davis) had no mortality in his early cases against 81 per cent in his late cases. Bergfeld's[25] twelve-hour mortality of 45 per cent rose to 80 per cent at twenty-four hours and 100 per cent after that time.

The general mortality for the Charity Hospital series was 52 per cent, seventy-eight of 150 cases. There were fifty-six deaths, 63.6 per cent, in the eighty-eight cases under two years of age, seven deaths, 21.9 per cent, in the thirty-two cases between two and fifteen years of age, and twelve deaths, 42.8 per cent, in the twenty-eight cases over fifteen years of age. Hipsley reported an 11 per cent mortality in the 486 collected cases and a 6.6 per cent mortality in 210 personal cases. Wade[3] reported a mortality of 14 per cent in 519 collected cases. Brown and Waterman (cited by Miller[26]) reported a mortality of 74.6 per cent in infants, 31 per cent in children and 36 per cent in adults.

The general mortality for intussusception is thus seen to be very high, though practically all series show an improvement in recent years. That improved surgical judgment and technic and better preoperative and postoperative care have played their part in the improvement there can be no doubt. On the other hand, perhaps even more important are the indefinite factors arising from the education of the laity in regard to the importance of early medical treatment in acute abdominal conditions, and the growing tendency on their part to seek earlier hospitalization.

Of the thirty patients who received no surgical treatment in this series, six either improved spontaneously or recovered after barium enemas which were being given for diagnostic rather than therapeutic purposes. A seventh patient refused operation and left the hospital against advice. The diagnosis was definite in all of these cases. In the twenty-three remaining cases the diagnosis was either missed or the patients were moribund and died so promptly after admission that treatment could not be instituted.

POSTMORTEM FINDINGS

Postmortem examination, which was performed in sixteen of the seventy-eight fatal cases, sheds little additional light on the condition, with one exception. According to Elliot-Smith[27] the lethal factor in irreducible intussusception, especially in infants, is intestinal obstruction, peritonitis from the gangrenous loop being a rare complication. In the sixteen postmortem examinations in this series gangrene of the intestine was present in four of the nonsurgical and two of the surgical cases, and peritonitis was present in three surgical cases. In one nonsurgical case both gangrene and peritonitis were found. Since the peritonitis in the surgical cases can be assumed to be the result of the operative procedure rather than of the intussusception per se, these postmortem observations would seem to bear out Elliot-Smith's contention.

SUMMARY AND CONCLUSIONS

One hundred fifty-one cases of intussusception occurred in the Charity Hospital of Louisiana at New Orleans in the thirty-four-year period ending in 1938.

The general mortality of 52 per cent was considerably decreased in the later years of the analysis, when diagnostic and therapeutic methods were both improved.

Delay in seeking medical attention was the chief cause of the shocking death rate, although in some instances the outcome might have been better had radical surgery been used, or had additional unnecessary surgery been omitted.

In age distribution, type of pathology, symptomatology and causes of death this series does not differ from other reported series.

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REDUCED TEMPERATURES IN SURGERY

I. SURGERY OF LIMBS

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FOR about ten years I have been trying to make an experimental approach to the problem of diabetic gangrene, and have carried out the observations at intervals whenever the existing obstacles could be circumvented. The views expressed in this paper rest on a growing series of clinical cases observed since the first announcement[1] in 1937 and especially on a primary laboratory foundation comprising hundreds of experiments on rats, rabbits, cats and dogs.[2–8] Prevailing conditions seem to warrant a general outline of ideas and methods, though the work is still in progress and more detailed reports will be published elsewhere. Some statements made here briefly or doubtfully may be subject to correction or amplification with larger experience.

EXPERIMENTAL METHODS

In order to study conditions of inadequate circulation, observations were made on tissues deprived of all blood supply by a tourniquet. The essential finding was that the modification of local metabolism by temperature enormously influenced the survival, from a few hours or even minutes at elevated temperatures to fifty-four hours at a temperature near freezing. No attempt was made to attain a maximum time limit, but the preservation of isolated tissues for weeks and months in the icebox is familiar; and if technical difficulties were overcome, it seems possible that attached limbs might be kept bloodless for very considerable periods and then restored to usefulness.* It is noteworthy that during fifty-four or more hours of refrigeration the blood does not clot, the vessels do not suffer damage resulting in subsequent thrombosis and the skin and other tissues remain fresh and intact. Paralyses and other nerve injuries are either prevented or minimized by cold. The investigation properly included systemic shock, since this has relations with diabetic surgery on one hand and with diabetic coma on the other. Both primary and secondary shock are abolished by suitably low temperature.

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1. *Tourniquet.* The tourniquet consists of two turns of a rubber tube to create the narrowest possible zone of compression. The clamp holding the two ends is kept from pressing on the skin by means of a gauze pad. Correct application of the tourniquet is one of the important details. Empirical judgment has thus far been the only guide for the degree of tension, which should be the least that will positively stop all blood flow. Therefore, in some arteriosclerotic cases or in shock this tension may be less than in the normal and much less than in a hypertensive patient. The rule that a tourniquet must not be applied to a diabetic or arteriosclerotic limb is set aside by cold. Just as the vessels of normal animals can tolerate a tourniquet for a day or two, so also the clinical experience thus far has shown no signs of serious or lasting damage to the most arteriosclerotic diabetic vessels by constriction up to five hours at a temperature near freezing. But as excessively tight ligations produce ulcerations, paralyses and thromboses in animals, simi-

The general mortality of 52 per cent was considerably decreased in the later years of the analysis, when diagnostic and therapeutic methods were both improved.

Delay in seeking medical attention was the chief cause of the shocking death rate, although in some instances the outcome might have been better had radical surgery been used, or had additional unnecessary surgery been omitted.

In age distribution, type of pathology, symptomatology and causes of death this series does not differ from other reported series.

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REDUCED TEMPERATURES IN SURGERY

I. SURGERY OF LIMBS

FREDERICK M. ALLEN, M.D.
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FOR about ten years I have been trying to make an experimental approach to the problem of diabetic gangrene, and have carried out the observations at intervals whenever the existing obstacles could be circumvented. The views expressed in this paper rest on a growing series of clinical cases observed since the first announcement[1] in 1937 and especially on a primary laboratory foundation comprising hundreds of experiments on rats, rabbits, cats and dogs.[2–8] Prevailing conditions seem to warrant a general outline of ideas and methods, though the work is still in progress and more detailed reports will be published elsewhere. Some statements made here briefly or doubtfully may be subject to correction or amplification with larger experience.

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lar consequences may reasonably be expected in patients. The practical experience indicates, however, that the margin of safety for these comparatively brief periods of only a few hours in patients is so wide that there need be no extreme fear in applying a tourniquet with any reasonable care.

2. *Refrigeration.* The first clinical employment copied the procedure used in animals, by having the patient sitting up or propped up at a sufficient angle to allow the leg to be immersed in ice water to a level about one inch above the tourniquet. The advantages of this method are that the cold is maximal, reaches every part of the skin and yet cannot freeze the tissues. Next, weaker patients were allowed to lie with only a slight elevation of the head of the bed, and with the protection of a rubber sheet the leg or thigh was placed on a layer of ice and covered completely with cracked ice. To obviate inconvenience and mess, a third step has been taken by using ice bags. The thinnest and most flexible pure-gum bags should be used, and three to five teaspoonfuls of salt added to each.

The limb is first surrounded with a few ice bags at the level chosen for the tourniquet. Within five to fifteen minutes the skin is chilled so that the application of the tourniquet may cause scarcely any discomfort. If the limb contains any important amount of noninfected blood, it may be elevated to drain out as much as possible and the tourniquet applied while it is vertical. Immediately thereafter, the limb is completely buried in ice bags to a level several inches above the tourniquet. Any pain or discomfort quickly subsides under the influence of the cold. A preliminary morphine hypodermic or other sedative may be helpful on account of nervousness in some patients, but as far as anesthesia is concerned no drugs are required.

Tests of the refrigeration should be made by occasionally inserting an ordinary laboratory thermometer between the various ice bags and the skin. Readings slightly above or below 5°c. assure the desired combination of adequate chilling and safety against actual freezing. A simple special apparatus for this purpose is under consideration and may be improved if the method is widely adopted, but the use of ice or ice bags will permit of trials in any hospital or even under makeshift emergency conditions.

3. *Anesthesia.* The time required for complete through-and-through anesthesia varies with the depth of tissue. It may possibly be as short as one hour for an emaciated shin or as long as five hours for a rather thick thigh. If it is not possible to cut the sciatic nerve at midthigh without attracting the notice of the conscious patient and without any change in pulse or blood pressure, there has been something wrong in the method of preparation. This physiological blocking of nerve conduction by reduction of temperature has some evident advantages over drugs employed either locally or systematically for this purpose.

Still more important is the realization that every form of anesthesia known or used heretofore is limited to mere nerve anesthesia, while refrigeration introduces the fundamentally new conception of anesthesia of protoplasm. It is a matter of elementary knowledge that plants and protozoa without nervous systems exhibit chemical protoplasmic reactions to injury. Equally familiar is the fact that operations under any known anesthetic are productive of shock in proportion to the duration and degree of tissue trauma. Mitigation of this recognized harm has been sought only through speed and delicate precision of the skilled operator. Crile had a true vision in his anoci-association, but only refrigeration inhibits all protoplasmic activity including the shock response. Thus for the first time the surgeon has the opportunity of working in a bloodless and shockless field. Such details as duration and extent of dissection are wholly immaterial; all that matters is the condition left after completion. Shock is nonexistent except for the (usually slight)

degree of it which may develop from the tissue injury remaining after the wound is finally closed and the temperature is raised to allow the protoplasm to resume its functions. This explains why a reasonably strong patient, after a thigh amputation by this method, can immediately return to the ward and eat a full meal as though nothing had happened, and in general why this anesthesia offers a radically new approach to the ideal of accomplishing an operation while maintaining a constitutional condition as if there had been no operation.

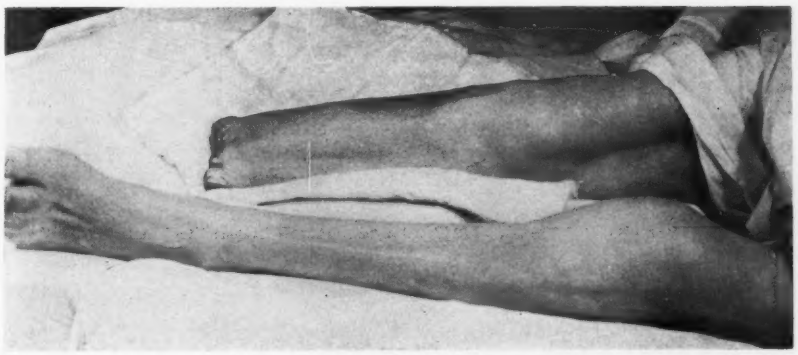

FIG. 1. Illustration showing leg of woman five days after amputation.

4. *Operation.* It is assumed that the tourniquet has been placed at the lowest level which will permit of preparing a sterile operative field and also not impede the sawing of the bone or other procedures. In the operating room the limb is removed from its nest of ice bags and the sterilization and operation completed as usual. No extraordinary haste is demanded, because the chilled tissues remain cold during an ample time for an ordinary operation. A rise of temperature does not affect the anesthesia, which is still thoroughly maintained by anoxia, but it is inimical to the perfect preservation of tissues and avoidance of subsequent shock. If saline solution is to be used for sponging or other local purposes, it should be iced. For any particularly long operation the limb may be kept on a bed of ice bags. Contrary to usual custom, the cooler the atmosphere of the operating room the better, and there is even the possibility that for operations lasting one to several hours the windows might be opened in winter or artificial cooling provided in summer.

When all is in readiness for closure of the wound, the tourniquet is released. Circulation returns promptly, in a degree proportioned to the existing arterial supply, and bleeding points can be caught and ligated. The anesthesia then continues at least long enough for convenient completion of suturing.

5. *After-Care.* The guiding principle of postoperative management is to reduce the temperature to whatever extent may be necessary but to raise it as fast and as far as may be safe. In cases with an adequate blood supply, there is no objection to letting the stump return immediately to normal body temperature. The abundant proof of normal healing in animals by this method has been duplicated in the small human experience including both thigh and calf. But by means of temperature regulation a whole series of important new controls become available when needed:

(a) When there are threatening signs of loss of vitality in wound flaps or mutilated tissues, the surgeon heretofore has stood helplessly by and watched them slough. The sloughing is obviously due to a deficient supply of nutrition, especially oxygen. There is no means for an immediate and effective increase of blood supply, but it is immediately possible to reduce the tissue metabolism to a level for which the existing blood supply is adequate. When necessary the temperature can be lowered to a point at which tissues can survive for a considerable time without any circulat ion

Some experiences indicate that such control can actually be maintained during a critical period until the circulation improves.

(b) If the operation, shockless in itself, has left damaged tissues which may set up postoperative shock, especially in a weak patient, this danger period can be bridged by temperature control. Shock production by tissues is inhibited in proportion as their temperature is reduced. The temperature may be raised gradually according as not only the local tissue vitality but also the constitutional state may permit.

(c) A fundamental problem of surgery is created by the tendency of wound edges to agglutinate and thus seal up collections of fluid which are liable to become decomposed or infected. With refrigeration just as with other forms of anesthesia, it has proved possible to close wounds completely without drainage under favorable conditions, as in the thigh. But diabetic or arteriosclerotic limbs commonly present special difficulties, because of the dangers of pressure from close coaptation of the edges, while drains have recognized disadvantages including the irritant action of a foreign body. It is known from animal experiments that the most active of all agglutinating processes, namely, that of peritoneal surfaces and especially of the omentum, is completely inhibited by cold. Human operations have added the information that agglutination and drainage in wounds can be similarly controlled. For an undetermined length of time, certainly for a number of days, the wound margins can be kept healthy and in close approximation, yet not sealed. Discharge may continue abundantly; and even if it is dark at first because of the state of the tissues, it rapidly changes under cold. It cannot decompose or become infected because enzymes and bacteria are checked by the low temperature. The profuseness of the flow shows that circulation and exudation are active at this temperature, and the bright red hemoglobin tinge indicates that oxygenation is ample and putrefaction absent. This remarkable washing of the wound with fresh exudate offers a new solution to the drainage problem, but it also can be combined with the use of drainage tubes when desired because the chilled tissues do not resent the contact of a foreign body. By raising the temperature at any time the wound margins can be made to agglutinate within a few hours and the exudate assumes the usual character or ceases.

6. *Healing.* A suitable degree of cold can maintain a peculiarly normal appearance of tissues, the skin white, the fat yellow and the muscle bright red, like perfectly preserved meat in a refrigerator. This appearance is both the result and the proof of retarded tissue metabolism. This arrest of metabolism implies a corresponding arrest not only of agglutination but of all other healing processes. Therefore, instead of the usual alternatives of prompt primary union or a breakdown followed by granulation, the surgeon encounters a new phenomenon, namely, a wound healing strictly per primam but requiring a multiple of the usual time. He must, for example, accustom himself to remove skin sutures after ten to twenty days. It is impossible to force an activity of tissues beyond the limit set by their blood supply, and the insistence that arteriosclerotic limbs must attempt to heal themselves at the normal rate has caused past disasters. Slow healing is better than no healing. On the other hand, the duration of the healing period is important for the patient and for the hospital which must house him. Therefore, the temperature of the stump should be raised from day to day up to full normal body temperature with such rapidity as the examinations indicate to be safe. On purely theoretical grounds it may be hoped that intelligent use of slightly higher temperatures at the right stage in favorable cases may appreciably shorten the convalescence.

7. *Thrombosis.* Spreading thrombosis, sometimes extending rapidly up a limb and entailing a correspondingly rapid gangrene, is due to damage of the vessel walls, arising

from bacterial action in infectious cases, from lack of nutrition and oxygenation in pure arteriosclerotic cases, or often from weeks or months. In general these effects are greatest in proportion as the operation involves sensitive and centrally located

Fig. 2. Low calf amputation with refrigeration, performed by Dr. W. F. Ruggiero in City Hospital, New York, for arteriosclerotic gangrene and infection of entire foot; man aged eighty-three years, fourteen days after operation.

combinations of these two causes. The absence of coagulation in the ligated refrigerated limbs of animals is presumably due not so much to an inhibition of the clotting process as to a preservation of the vessel walls by cold. As bacterial activity is also prevented or retarded, the danger of thrombosis should theoretically be avoided or minimized. This expectation seems to be fulfilled by the absence of any sign of this danger in the experience thus far. This principle may therefore prove useful, in addition to heparin, for the treatment of other conditions in any accessible parts of the body.

8. *After-Shock.* There seems heretofore to have been no discussion and nothing but tacit acceptance of the more or less prolonged asthenia following operations. The procedure may involve apparently trivial trauma, only brief anesthesia, small incision, absence of infection, hemorrhage or immediate prostration, and little or no tissue left for later absorption; yet after a simple appendectomy or other operation conforming to these terms a previously strong and healthy patient may experience more or less debility continuing for several organs, or with peripheral operations in proportion as large nerves and muscle masses are cut. When refrigeration anesthesia prevents the appearance of any of the signs regarded as diagnostic of primary or secondary shock, and when the patient has unimpaired appetite during the immediate postoperative period, it is interesting to learn whether he may also be spared this state of delayed shock. A clear answer cannot yet be given, because thigh amputations even when healing by primary union entail absorption of broken down tissue products and often also products of infection. All that can be said, therefore, is that following thigh amputations there is still a perceptible depletion of strength. The experience to date gives the impression that this debility is decidedly reduced by refrigeration as compared with former methods, but it may still be a source of danger to extremely feeble patients. On the other hand, with properld managed lower leg amputations this after-shock approaches the vanishing point. One of the greatest advantages of the refrigeration method, therefore, consists in promoting the success of these milder operations which

make the smallest wounds, thus favoring the survival of weak patients, or in stronger patients allowing a series of conservative trials to be risked with impunity.

DIABETIC GANGRENE

As diabetic gangrene furnished the starting point of this research, it should be discussed in a little more detail. Confessedly, the current management leaves much to be desired and the mortality is high. In no other chronic condition is prophylaxis more essential or more successful, because the arterial and other complications can be prevented by timely and thorough care of the diabetes; and a heavy responsibility is borne by those who encourage the reckless laxity which finally brings the terrible and hopeless thickening of arteries not only in the legs but in all parts of the body. When this condition has arrived at an advanced or terminal stage, no treatment can be expected to work a miracle. Nevertheless, as I find some patients living comfortably five to fifteen years after medical or surgical cure of gangrene, an effort toward lower mortality and greater longevity is not wasted. The particular question for present consideration is whether the use of cold can add anything to the existing treatment, especially in the most unpromising and desperate cases. We must first consider treatment which seeks to save the limb from amputation.

1. *Conservative Treatment.* Physicotherapy offers a variety of useful aids, none of which need be overlooked or disparaged. There has been abuse of heat treatments with the intent to promote hyperemia, but with disregard of the fact that it raises the local metabolism so as to create a need for more blood while an appreciable increase of flow through the rigid arteries is impossible. As it has become recognized[9,10] that the temperature of the feet under normal conditions is commonly lower than that of the central parts of the body, the possible dangers of warming arteriosclerotic extremities to a point equalling or exceeding the rectal temperature can be better appreciated. These simple relations between local metabolism and blood supply explain the thermal sensitiveness of the tissues in vascular disease, for example, the burns from water bottles or electric pads, and the case which I have mentioned elsewhere of gangrene in the feet of a diabetic from a Turkish bath which was not uncomfortably hot to other persons. Nevertheless, heat is valuable in the treatment of some cases of gangrene and for years I have tried vainly to obtain facilities for what may be a more rational mode of administration. Tests may perhaps be devised to distinguish cases which are suitable for heat or cold, respectively, but one simple and fairly decisive test is the patient's comfort. Regardless of any theory, an increase of pain or discomfort by cold may be regarded as a contraindication to any prolonged use of it. On the other hand insufficient attention may have been paid heretofore to complaints of burning sensations and of increased discomfort with heat applications or even with warm coverings. Cold may be acceptable to some patients either because of insensibility of the nerves or because it actually relieves pain.

It is made clear in the useful classification of Williams and O'Kane[11] that the designation of diabetic gangrene covers cases ranging from practically pure arteriosclerosis at one extreme to practically pure infection at the other extreme, but the vast majority are mixed in varying degrees. Therefore, the possible effects of thermal changes should be estimated in relation to these two factors.

(*a*) *Arteriosclerosis.* There is a radical difference between a ligated limb and one with a normal blood supply. The circulatory reaction in the latter is one of the important objects and aids in physicotherapy, but at the same time it limits the ability to produce artificial temperature changes in the deep tissue. In proportion as arteriosclerosis is present the condition approaches closer to that of the ligated limb, and external applications can warm or chill the tissues through and through

with unusual ease. The small trickle of blood does not provide the usual efficient temperature regulation; on the contrary the blood itself can be heated or cooled along with the tissues. Accordingly, advanced arteriosclerosis creates a remarkable condition in which the local metabolism in certain parts of the body is subject to the environmental temperature almost as definitely as the metabolism of a frog. Omitting theoretical discussions of this interesting condition, the practical statement can be made that reduced temperatures seem to be well tolerated for considerable periods when the cases and conditions are properly chosen; fears concerning reduced blood flow or other dangers have not yet materialized, and the progress of arteriosclerotic gangrene may possibly sometimes be delayed. On the other hand, the case record included in this paper proves that a severe process of this type may continue to advance in spite of the attempt to reduce the tissue metabolism to correspond to the reduced blood supply. A definite opinion must, therefore, be withheld pending fuller experience. Furthermore the incurability and possible progressiveness of arteriosclerosis limit the possibilities.

(*b*) *Infection.* Arteriosclerosis creates an opportunity which is practically unobtainable in tissues with a normal blood supply, namely, the ability to make a through-and-through reduction of temperature low enough to arrest activities of pathogenic bacteria. Some facts bearing on this condition are stated elsewhere. The usefulness for the conservative treatment of diabetic gangrene is not a matter for theoretical hope or condemnation but must remain to be decided by longer experience.

2. *Surgical Treatment.* Proper control of temperature can be an aid to conservative surgery. The remarks concerning drainage, shock, tissue vitality, etc., in the first section of this paper are applicable to drainage treatment without amputation or the more conservative forms of amputation. An example may be the prevention of failures of healing with plastic types of operation. Likewise the opportunity for amputations through the calf may be enlarged. The present discussion, however, will go further into the problem of surgical mortality in critical cases. Two of the principal forms of emergency will be considered as examples.

Fulminating Infections. Retention of a hopelessly infected leg may mean certain death, while amputation often carries extreme risk from shock alone or from lowering of resistance to a beginning systemic infection. New and old uses of cold may be distinguished as follows: (*a*) Ice bags for various purposes have long been familiar, and some of the older surgeons occasionally packed infected limbs in ice. (*b*) Dr. Temple Fay and collaborators[9,10] opened a new epoch not only with more efficient means of local chilling but also with the brilliant and daring discovery of general systemic refrigeration, as a broad biological approach to problems inclusive of cancer, pain and infection. These striking contributions should be more highly appreciated and further developments encouraged. (*c*) The present work had a different and narrower origin. Its distinctive original feature is the use of the tourniquet with cold. In other respects it is an adaptation of previously known principles.

The existing situation today is that in the most desperate cases surgeons customarily take the risk of a high amputation or else let the patient die as inoperable. It is clear that refrigeration offers an alternative, and the use of a tourniquet can add all the advantages of operation without the shock. The simple packing in ice will often transform both local and general conditions and may check pain and the advance of sepsis for perhaps several days. When necessary, the tourniquet can give a still more decisive result, obviating the need of morphine and the waste of time and strength in preparing for operation. If applied promptly by anybody on the resident staff, it will within a few hours permit of amputation without an anes-

thetic and with minimal shock. If the condition is so extreme as to make any operation inadvisable, the limb can be left for a few days or can be harmlessly amputated or disarticulated anywhere below the tourniquet in order to reduce the mass to be kept refrigerated. The time for the finished amputation can then be selected according to the patient's strength.

It is important to warn that when a tourniquet has been in place for one to several days, it must never be removed or allowed to slip. An excessively rapid and fatal intoxication may result. At the proper time another tourniquet may be applied a few inches above the original one, and after the few hours necessary for anesthesia the amputation may be performed a little above the original tourniquet.

Amputations of Election. Somewhat less urgent but more numerous are the cases of lower grade infection or of dry gangrene. At present there is only a minor difference in judgment concerning a few of these cases, whether to get rid of the focus of intoxication by a preliminary low guillotine operation (McKittrick) or to make a finished procedure in one stage. The end in view is nearly always the same, namely, a thigh amputation. Statistical results are comparatively good in a few institutions having the advantages of special skill and organization. The fact remains that the great mass of these cases are treated in public hospitals, where the deplorably high mortality is accounted for not only by the possible lack of specialization but also by the wretched average state of the clientele. The age and complications in many of these cases will create a considerable mortality regardless of any medical or surgical efforts. We may, however, distinguish a certain large nucleus of mortality which is due to enforced major amputations upon poor risk subjects. The elementary facts can be further analyzed as follows:

First, the risks of high amputation are taken because of the proof through long experience that low amputation wounds generally will not heal. But gangrene nearly always starts in the feet. Except in a small minority, the indications are that all tissues above the ankle could have remained safe throughout life had there been no trouble in the foot. In fact, the rules for care of the feet stressed by Joslin and all other writers are based on the assumption that prevention of small injuries and infections will often allow the feet also to survive without gangrene. Therefore, the failure of tissue survival after operations anywhere below the thigh must be due to something connected with the operation.

Second, this operative injury may be subdivided into the factors of local shock, infection and edema. Accessory causes of trouble have been: (a) too high local temperature, due either to artificial heat or unduly warm dressings and coverings; (b) the abuse of saline infusions, for in the zeal to provide circulating fluid it has been forgotten that salt solution increases the tendency to local edema, and the pressure of edema upon capillaries is a cause of disaster with feeble circulation. The tissues which could survive if uninjured are unable to withstand this multiple damage. It has already been explained that refrigeration combats all of these factors and will thus conduce to healing after conservative operations.

Third, the rules for amputation sites for the best functional results in favorable cases are not the object of this discussion. The one point for consideration is the saving of life in the worst cases. Concerning these arteriosclerotics the radical thesis may be proposed, at least for debate, that surgeons directly cause many deaths by clinging to the traditional practice of amputating through the thick bellies of muscles in the thigh or calf. Because the foot is a complex of structures supplied by the smallest arterial branches, amputations anywhere in it are recognized as not feasible except in the small minority of cases with best circulation. But amputations in the supposedly forbidden zone of the lower half or third of the tibia can be defended

in comparison with the traditional elective sites by the following arguments:

(a) The smallest wound produces the least shock and should also be the easiest to heal.

(b) The muscle masses possess the largest blood supply for the very reason that they demand the most blood. Therefore, they slough easily with a deficient blood supply and the necrosis of these large flaps is ruinous. Shock is maximal.

(c) The usual amputations below the knee have the above disadvantages, also the weight and pull of the calf muscles contribute to force the tibia through the skin. The small mass of the flaps near the ankle imposes less strain on the skin. Also if any sloughing occurs, there is a chance to wait for granulation and saw off the bone again because of the small wounds and small shock in these procedures.

(d) A traditional objection is that the lower shin consists largely of tissue of low vitality. The very fact of the low vital activity of tendons and fascia furnishes the reason why they can survive with less circulation.

(e) The chief argument, namely, that there is not enough blood supply in the ankle region, may often be untrue. The bone, which composes most of the diameter, has its own blood supply for its own small needs, and practically never sloughs primarily. As was previously explained, there is ordinarily enough blood supply not only for the scanty soft tissues of the shin but often for the larger mass of the foot, if there were no wound. The problem, therefore, is merely that of tiding over the brief period of the recent wound.

(f) Particularly in shrunken arteriosclerotic limbs, it can be objected that a lower shin stump will be pointed, tender and liable to ulcerate. All this is immaterial in comparison with saving of life. If the patient is never to walk, as is admittedly true with a large proportion of thigh amputations in senility, there is a minimal chance of trouble with any stump. But walking does not demand that the stump end shall bear weight or be chafed; and with a suitable prosthesis for carrying weight on the bony expansions about the knee there should be more chance of walking, and of better walking, than with thigh amputations.

(g) The possibility that the small atrophic stump may be subject to neuritis or to further gangrene as a result of progressive arteriosclerosis cannot be settled in advance, but such risks seem small in comparison with existing dangers in these cases.

The general import of this argument is that refrigeration can reduce surgical mortality by reducing the number of enforced major operations as well as by making them more easily borne. Actual experience to date indicates that the best amputation as a rule is, according to the individual case requirements, either of the Callender type or else in the lower part of the calf muscles, in both instances avoiding the largest muscle masses.

CASE REPORT

The following case, though finally fatal, illustrates certain uses of reduced temperature in an advanced and somewhat atypical case of arteriosclerosis:

A housewife, of an age unknown to herself or family but obviously senile, was seen September 9, 1940, in bed on account of severe pain in the great toe of the right foot. Moderate discoloration when dependent and other clinical signs of arterial obstruction were present. No pulsations were palpable in the popliteal artery of either leg or anywhere below. Subsequently two consultants made oscillometric tests, which showed slight pulsations in the thighs, extremely slight just below the knee, and nothing lower down.

The history was the familiar one of glycosuria known and neglected for fifteen years, with good general feelings and no loss of weight. The more recent years included one "heart attack," one psychosis for several weeks following operation, and one incipient gangrene of the right foot cured without stopping of glycosuria. One physician previously consulted for the present attack refused to give insulin because of moderate indications of coronary disease in the

electrocardiogram. Routine examinations of the heart and other organs were negative.

The diet was only slightly changed in quantity but was weighed to keep it uniform. The urine and blood were made normal by means of insulin, which at one time reached a maximum of 60 units divided into four doses daily. With fractionation of the carbohydrate allowance there were no hypoglycemic or cardiac attacks.

The control of the diabetes gave quick relief of pain, but the case was exceptional in that this improvement was brief and the further progress seemed unaffected. Another short period of relief was given by nitroglycerin, and after that by various sedatives. Vitamins seemed not indicated but were tried briefly in vain. Warmth was tried in the form of mild artificial heat or merely warm coverings, but the patient resisted them as increasing the pain at all stages. Ice bags were welcomed and gave full relief for a few days but later had little effect. The pain increased in extent and especially in intensity, without any sign of gangrene, until it dangerously exhausted the patient's strength and she begged for amputation.

Instead, it was ascertained that novocaine injections of the principal nerves stopped all pain for a few hours. Accordingly it was decided to risk a trial of nerve section. Using novocaine, Dr. J. J. Nutt, on October 31, sectioned the anterior tibial and musculocutaneous nerves in the upper calf and the posterior tibial by another short incision behind the malleolus. The posterior tibial artery was found to be a hard bloodless cord and the cut tissues did not bleed appreciably. The slight operation was followed by nearly complete cessation of pain but also by complete disorientation (supposedly connected with the cerebral arteriosclerosis) and urinary incontinence followed by retention. The taking of nourishment was not interrupted, and after four weeks the disturbances cleared up. The principal fear was that the slightest separation or infection of wounds in such a leg would be a starting point for gangrene. Therefore, reduced temperature was employed from the outset, first with ice bags and later with exposure to a cool atmosphere. Healing occurred strictly per primam but with extreme slowness, so that narrow lines of superficial crust were still present two months later.

Meanwhile a gradual darkening began in the third toe and progressed to mummification, and this process spread to the two adjacent toes and then into the foot. Apprehension was felt that the advancing arteriosclerosis might be related to two unorthodox features of the treatment, namely, the reduced local temperature and salt-free diet. Therefore, tests were made which gave unfortunately positive results in this case, regardless of what may hold for other cases, and without these tests the outcome might possibly have been different. Two trials were made of keeping the leg warmly covered, with the result of an accelerated advance of the discoloration, also a threatening appearance of the wound behind the internal malleolus. On two other occasions salt was tried, with avoidance of hypertonic solutions which were said by the family to have caused serious shock in a former experience. On the first occasion salt was added to the diet ad libitum, and two liters of plain physiological saline were given by slow intravenous infusion in the course of the day. On a later occasion 2 Gm. of salt were added to the diet and one liter of saline was infused. Each time there was an immediate appearance of better circulation in the foot, but after twenty-four hours a slight edema was present. Over areas adjacent to the gangrene the epidermis was lifted up by a slight transudation from the soggy tissues, and these superficially blistered areas immediately turned black. In this way a rapid extension of gangrene occurred into the adjacent toes and then in the foot.

Although the advance of the gangrene was not stopped, it seemed to be distinctly slower at low temperature. Also no infection or wet gangrene appeared, and the rectal temperature remained strictly normal throughout. When the discoloration extended half-way back in the foot on both dorsum and sole it was agreed that a trial of a low amputation was preferable to the practically certain fatality of a thigh operation.

Therefore, on December 22, the leg was surrounded with salted ice bags from the knee downward, to give readings of about 5°C. on a thermometer inserted between bag and skin. A rubber tube was applied as a tourniquet around the calf for three hours—doubtless an unnecessarily long time. Dr. Robert E. Brennan then amputated in the lower third of the tibia, barely shaping the flaps and avoiding all dissection. He also omitted bevelling of the tibia upon request, which was probably an error. The obliterated arteries did not bleed and the tissues were nearly bloodless but a few catgut ligatures were placed as a precaution. A very light dressing of only a few thicknesses of gauze was applied with ice bags arranged outside it

so as to avoid pressure. The thermometer readings inside the dressings were kept at about 15°C. for the first twenty-four hours, and gradually raised to 35°C. by the end of a week. A rubber tube drain was withdrawn after only twelve hours, but a clear reddish drainage continued rather freely for several days until checked by the rise of temperature. The wound edges remained perfect. In spite of the small weight of the flaps, the sharp crest of the tibia made a threatening pressure point on the skin, which cleared up with support of a posterior pad and increased refrigeration anteriorly for two days. No physical or mental disturbance appeared following the operation. After one week, when the patient was symptom-free and was hoped to be out of danger, the pulse rate dropped suddenly to 50. A blood analysis showed the sugar was not low but instead had risen to 250 mg. Death ensued early the next morning, presumably from heart block.

Figure 1 shows the thigh with a large fold of flabby tissue and the shrunken lower leg. The wound flaps and the point of exit of the former drain are free from any trace of necrosis. The death appeared to be unrelated to this small operation. The complete healing of the neurotomy wounds and the smooth beginning of healing after the amputation seem to illustrate the possibilities in an extremely advanced stage of arteriosclerosis.

MILITARY SURGERY

Refrigeration is applicable to other conditions not handicapped by senility and arteriosclerosis. One of the strongest reasons for presenting the subject at this time is its apparent value for war wounds. Industrial accidents furnish a more continuous supply of similar cases.

The theory of shock should be considered with reference to the nervous and chemical causes. For the latter I proposed the tentative and unsatisfactory names of histotoxins and histotoxicosis. The combined nervous and humoral action is not inherently harmful, but rather serves to produce dilatation and increased permeability of blood vessels as the primary stage of a normal defense and repair. Hypothetically, an excess of this reaction, either absolutely or in relation to the available blood supply, may be locally injurious and warrant the name of local shock. The most severe and extensive injuries, through excessive nervous stimulation and the flooding of the circulation with histotoxins, produce effects such as low blood pressure and abnormal vascular relaxation and permeability to a degree which may be fatal. Whatever progress may have been made in the treatment of any of these factors in shock, the pre-eminent desideratum is still prevention. A large number of both military and industrial wounds consist in mutilations of limbs, and to these the results of animal experiments are clearly applicable as follows:

1. *Emergency Facilities.* In warm weather ice is often available or can be specially provided. In cold weather only precautions against actual freezing of parts may be needed. The chilling is so simple that it can be carried out by any reasonably intelligent nonmedical persons.

2. *Tourniquet.* A tourniquet is often needed to stop hemorrhage, and it sometimes remains in place for several hours pending surgical treatment. Histotoxins are produced in proportion to the mass of asphyxiated tissue and the duration of the asphyxia, and they are poured into the circulation upon removal of the tourniquet. Ligation of one entire hind leg for five hours is enough to kill a rat, and deaths from this cause alone have been reported in human cases. In nonfatal cases there will still be various degrees of reduction of strength and resistance. Efficient chilling prevents this shock effect largely or entirely, and also wards off local gangrene when the tourniquet is retained for an excessive length of time.

3. *Transportation.* The transportation of wounded persons can be made entirely painless as far as limb injuries are concerned. There is probably better preservation of strength and resistance than with large doses of sedatives.

4. *Anesthesia.* The wounded may arrive at a hospital after several hours, ready for immediate operation without any additional anesthetic.

5. *Shock.* The prevention of shock before, during and after operation was previously described. A caution maybe necessary concerning the time limits. Although it is possible theoretically to conceive of a preservation of ligated limbs for several days, any apparatus that could carry this theory into practice would be too complicated for emergency use. Mere external icing is inadequate for prolonged through-and-through chilling of thick limbs, notably the human thigh, and internal parts near the tourniquet may still be warm enough for gradual toxin formation or even necrosis. Appropriate precautions should therefore be taken, even to the extent of amputation, if a tourniquet has been in position perhaps for eighteen hours or longer.

6. *Infection.* When any parts are potentially infected, perhaps by being macerated with dirt and foreign material, refrigeration serves the important purpose of holding everything in abeyance. Bacteria cannot grow or invade. Tissue vitality and resistance are preserved. In cases of existing active infection, the animal experiments and a few clinical observations indicate that ligation and refrigeration can be used long enough for operative anesthesia, without benefit and also without apparent harm as regards the infectious process. Any extreme prolongation of ligation of an actively infected part creates dangers of intoxication and death which necessitate precautionary amputation.

7. *Ultimate Results.* The preservation of tissue together with suitable temperature reductions in the postoperative care, should facilitate conservative and reparative operations and aid in avoiding amputations and crippling.

The chief difficulty will perhaps consist in persuading surgeons that a refrigerated limb, no matter how cadaveric it may appear, actually retains vitality so as to offer the above stated advantages; and that therefore one of the most revolutionary achievements of this method may be hoped for in the field of military and emergency surgery. A very striking case of this type is described by McElvenny.[12]

EMBOLISM AND OTHER ACCIDENTS

Embolism of a main artery is one of the conditions in which warming a limb is most disastrous. Any person present may be instructed as early as possible to surround the limb with ice. A suitable degree of refrigeration will be the most important nonoperative treatment. In case of a high embolism which obviously demands operation, a physician should preferably use brief elevation to drain out all possible blood, then apply a high tourniquet to stop all inflow from collateral vessels. The refrigeration will then have its usual effects in inhibiting pain, shock, tissue damage and intravascular thrombosis, besides permitting of operation without an added anesthetic. Postoperative regulation of temperature is also important to suit the individual case. Reduced temperature can further restrain thrombosis, necrosis and infection. Parts which lack circulation are fortunately the ones which can be most effectively chilled, hence they can be aided in survival until collateral circulation has a chance to develop. The method should make a transformation by extending the time limits for embolectomy and improving the results.

Refrigeration is of questionable value for ordinary fractures, and account must perhaps be taken of the increase of tissue rigidity by cold. For open fractures the previously stated principles concerning infection are applicable. Fractures damaging blood vessels may need treatment along the same lines as embolism. Fractures involving shock also come within the scope of these principles.

In addition to the obvious uses for plastic and reconstructive work, it may not be difficult to suggest other possible applications of refrigeration and the ideal of working in a bloodless and shockless field. The attempt will be made as opportunities permit to try further extensions both experimentally and practically.

CONCLUSION

Every new method must have its value tested, its limitations defined and its technic developed before it can receive an established status. The obstacles to investigation heretofore, together with the existing military emergency, furnish the reasons for presenting this method before these requirements have been fulfilled. A broad statement of theories has seemed desirable in order to stimulate investigation by those who have opportunities, even though one result of such work will doubtless be to destroy some parts of the speculative structure. The essential point which appears to be proved is that refrigeration possesses real value at least for some critical conditions. It may possibly be found suited for much wider applications. But there is as yet no proof that it can reduce the statistical mortality from diabetic gangrene, that it is superior to other operative methods in cases permitting of free choice, or that there may not be some harmful results of the drastic chilling in contrast to the usual careful conservation of tissue warmth.

Furthermore, the technic is still primitive, so that the best beneficial effects cannot yet be realized while harmful effects may be magnified. For all these reasons the first trials may properly be limited to cases regarded as desperate or inoperable, and this experience may serve as a guide to any wider adoption. Fundamental studies are the principal need, in order that undue enthusiasm over a spectacular novelty may not be followed by disillusionment which may obscure any real value of the method.

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OPEN SURGICAL REDUCTION OF FRACTURE DISLOCATION OF THE LUMBAR SPINE WITH CORD OR CAUDA EQUINA INVOLVEMENT

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THE clinical course and autopsy findings of fracture dislocation of the lumbar spine with cord or cauda equina involvement has been described as long ago and perhaps before the time of Guillaume Dupuyptren,[4] yet in the literature of this country and that of Great Britain, there is only one instance cited in which open surgical reduction has resulted in satisfactory recovery.[6]

Numerous authors[1,2,3,7,8] have proposed open reduction in fracture dislocation with locking of the articular processes but actual cases in which such a procedure has been done have not been included.

Of ninety-seven cases of compression fracture of the spine observed by Munro and Irwin in 1935 and 1936, nine patients were suffering from what appeared to be definite cord or cauda equina complications on admission to the Infirmary. Three of these nine patients were subjected to open surgical reduction[5] and, in those so treated, one showed no change but in the other two, the symptoms of cord complications were alleviated.

Munro and Irwin state in their conclusions that open operative reduction, though criticized because it has never yet "cured" a patient, appears to be a rational

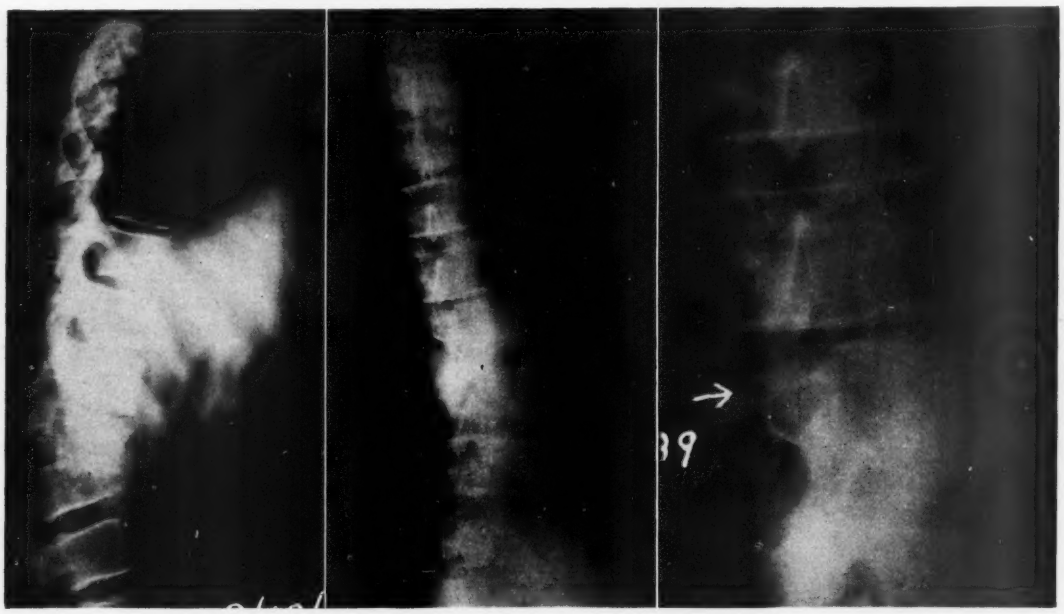

FIG. 1A. Lateral view.

FIG. 1B. Anteroposterior roentgenograms of lumbar spine of A. C., August 18, 1939, immediately after admission to hospital.

FIG. 1C. Enlargement of Figure 1A to show more clearly the position of the articular processes on the right side of L 1 and 2.

method of treatment when carried out early; and these authors express the hope that sometime a patient may be encountered and reported in whom injury to the spinal cord has not been so great as to cause irrecoverable cord damage. Therefore, the following case is presented in detail.

CASE HISTORY

A. C., a white man aged 46 years, was admitted to Samaritan Hospital in Ashland, Ohio, on the evening of August 18, 1939, following an automobile accident. Obviously the man had suffered severe spinal injury since the initial immediate examination showed an extreme kyphoscoliosis of the dorsolumbar region and a partial sensory and motor paralysis involving the right leg.

During the first four hours after admission a gradual extension of the paralysis was noted. At the consultation four hours after admission loss of motor and sensory function involved the entire right leg and the right half of the peroneum. A bulging forward in the left lower quadrant of the abdomen on coughing or straining was the only evidence of motor involvement on this side of the body. There was, however, definite hypesthesia over a rather large elliptical area in the left inguinal region, of the front of the left knee and on the dorsum of the left foot. The patient also voided involuntarily.

Anteroposterior and lateral roentgenograms of the spine (Figs. 1A and 1B) revealed a fracture dislocation involving the first and second lumbar vertebrae. The lateral view (Fig. 1A) shows some although not an extreme amount of anterior displacement together with an obliteration of the forward part of the intervertebral space and a widening of the space between the lamina of the two vertebrae. A compression fracture extending horizontally through the body of the second lumbar vertebra near the upper plate is faintly visible. In the anteroposterior view (Fig. 1B) there is an apparent lateral displacement to the right of the first on the second lumbar vertebra and compression of the right side of the body of the second lumbar vertebra.

Open operative reduction at this time seemed inadvisable and perhaps unnecessary if reduction of the lateral displacement could otherwise be accomplished. The principal obstruction to reduction seemed to be the position of displacement of the adjoining articular processes on the right side of the involved vertebrae. The tip of the inferior process of L 1 appeared to be

Fig. 2. Drawing of posterior view of L 1 and 2 to illustrate the position of displacement of the involved segments as interpreted from the roentgenogram (Fig. 1 C).

resting securely and a little lateral to the highest point of the tip of the superior articular process of L 2. (Figs. 2 and 3.) We believed the displacement could be favorably corrected by manipulation if it were undertaken carefully.

Scopalimine-morphine analgesia was used. After slight flexion away from the partially locked articular processes an attempt was made to derotate them from their fixed position. This was followed by traction and hyperextension. A complete disappearance of the apparent deformity resulted and, after a few hours, the patient stated that he felt greatly relieved. He voided involuntarily twice following the manipulation but bladder control returned thereafter.

Roentgenograms (Figs. 4A and 4B), made on August 19, 1939, the day after admission, show the change produced by the attempt at closed reduction. The lateral view (Fig. 4A) shows a seemingly favorable replacement of the forward dislocation of the adjacent bodies. The fracture line through the body of L 2, near its upper plate, is here more apparent than in Figure 1A and the compression appears to have been reduced. The anteroposterior view (Fig. 4B) indicates that there was little, if any, change in the lateral displacement as the result of the attempted reduction, and that any further

attempt at closed reduction would be dangerous and without benefit. The right inferior articular process of the first lumbar vertebra has been forced downward along the lateral side of the right superior articular process of the second lumbar vertebra so that the two inferior articular processes of L 1 are riding astride the right superior articular process of L 2 (Fig. 5), the lateral displacement being thereby locked in this position. That some compression of the right half of the upper plate of L 2 is still present is shown in Figure 4B.

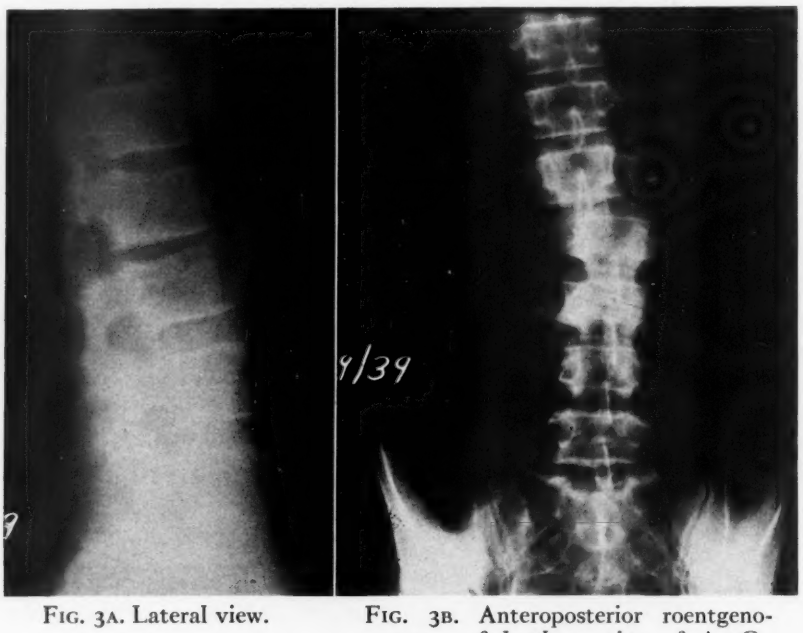

FIG. 3A. Lateral view.

FIG. 3B. Anteroposterior roentgenograms of lumbar spine of A. C., August 19, 1939, the day following attempt at closed reduction.

It was now apparent that an open operation offered the only means by which reduction could be accomplished and a chance for recovery attained. The local as well as the general condition of the patient necessitated that surgical reduction be delayed until August 27, nine days after the injury.

Under local anesthesia the spinous processes of the involved vertebrae were exposed through a curved incision passing to their left. An irregular tear which had completely divided the supraspinous and interspinous ligaments extended laterally to involve the lumbar fascia beyond the area of exposure. Extensive damage to the left latissimus dorsi and sacrospinalis muscles had resulted in widespread extravasation of blood which had become organized.

The spinous process of L 1 was displaced laterally so that it was in the same longitudinal plane as the right superior articular process of L 2, and the latter was securely placed between the inferior articular processes of L 1 (Figs. 4B and 5) preventing rotation. By grasping the spinous processes of the involved vertebrae with boneholding forceps it was found that their longitudinal position could be appreciably changed by slight traction but not enough to disengage the articular processes. When the spine was flexed by lowering the ends of the operating table and an instrument placed between the spinous processes to steady and help direct the procedure (Fig. 6), reduction was accomplished with surprisingly little force. As a precautionary measure, to prevent redislocation, the spinous processes of the involved vertebrae were secured in position by a piece of surgical wire passed through drill holes. The operative wound was closed without drainage and a plaster of Paris shell was then moulded to the patient's back.

Postoperative roentgenograms (Figs. 7A and 7B) show the degree of correction attained. The lateral view shows a perceptible backward displacement of the first on the second lumbar vertebra. In the anteroposterior view (Fig. 7B) complete reduction of the lateral displacement obtains. The surgical wire placed through the spinous processes is seen in both views.

During the two weeks following the injury, except for a sensation of coldness, there was

complete paralysis of the entire right leg. About the end of the third week, evidence of the return of muscle power in the toes was noted.

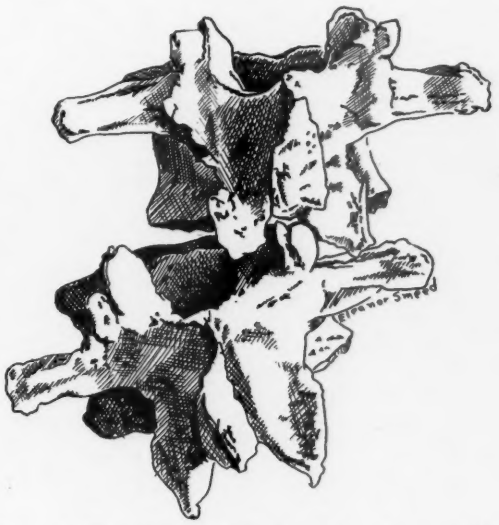

Fig. 4A. Drawing of posterior view of L 1 and 2 showing the position of displacement as interpreted from the roentgenogram (Fig. 3B).

By the end of the fourth week the patient could abduct but not adduct the entire limb. Gradual return of motor and sensory function continued; the hypesthesia of the left big toe, left knee cap and left inguinal region disappeared more slowly than that of other parts.

Ten days after operation, when the tension sutures were removed, there was a separation of the wound with a persistent discharge of a small amount of serous fluid. This was attributed to the surgical wire placed through the spinous processes. On December 10, 1939, this wire was removed and three weeks later the wound was entirely healed. The patient, now wearing body cast, was discharged from the hospital on December 23, 1939.

On February 19, 1940, exactly six months after the date of his injury the patient began sitting up and nine days later he stood up for the first time. By March 11, 1940, he was walking unaided and came to the table for his meals; the following week he went up and down stairs. On March 21, 1940, the body cast was removed and a back brace applied. Enemas were discontinued this same day and have been resorted to only occasionally since.

The patient's activities have gradually increased. During the month of April he was able to walk a distance of four miles without fatigue and on May 18, 1940, he drove his automobile for the first time.

On May 31, 1940, physical examination of this patient revealed the following conditions: He was still wearing a back brace (Fig. 8)

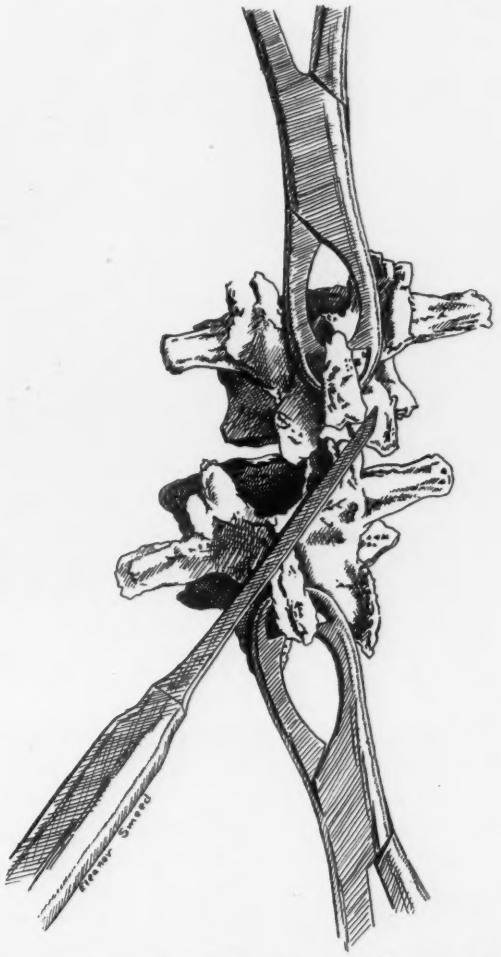

Fig. 4B. Drawing of L 1 and 2 to illustrate the manner in which reduction was aided.

except at night. His operative wound was well healed. (Fig. 9.) Although motions of his lumbar spine were somewhat limited there was no pain or discomfort on motion. By slightly bending his knees he could stoop over to pick up objects from the floor (Fig. 10) as easily now as he could before his injury. There was some weakness of his right leg but it would withstand his body weight even when the knee was flexed 45 degrees or more. (Fig. 11.) His right calf measured 12½ inches, the left 12¾; right thigh, 19 inches and the left 20½. The right Achilles and patellar tendon reflexes were less active than were those on the left side. Some weakness of the left lower abdominal muscles, evidenced by a slight bulging on coughing or straining, is still present. An area of hypesthesia, somewhat elliptical in shape and measuring about 2 to

4 inches is still present in the left inguinal region lateral to the mons pubis. The front of the left knee, the medial side and dorsum of the left big toe, the dorsum of the second, third and medial half of the fourth toes of the left foot are still hypesthetic.

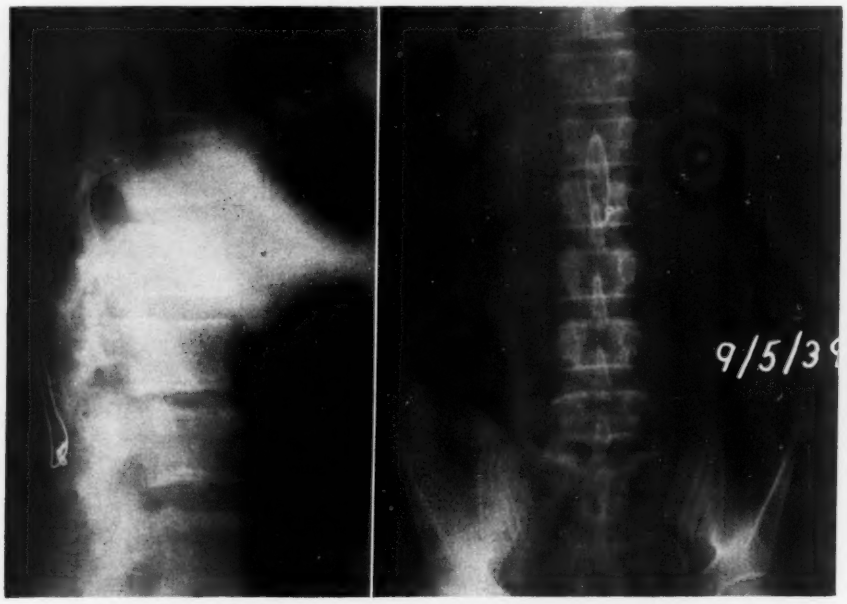

FIG. 5A. Lateral view.

FIG. 5B. Anteroposterior roentgenograms of lumbar spine of A. C., September 5, 1939, showing the degree of postoperative reduction.

The position and condition of the involved vertebrae at the present time is shown in Figures 12A and 12B. In the lateral view (Fig. 12A) the backward displacement of the upper on the lower segment is even more noticeable than in Figure 7A. Hypertrophic bone anterior to the bodies of L 1 and L 2 bridges these two vertebrae. In the anteroposterior view (Fig. 12B) hypertrophic bone, more abundant on the right than on the left, is seen at the lateral sides of the involved vertebrae, extending continuously between them. A slight lateral displacement to the right of L 1 on L 2 has occurred.

DISCUSSION AND SUMMARY

Fracture dislocation of the thoracic and lumbar spine with cord or cauda equina involvement, although not common, is by no means rare.[2,8] Even though there is no evidence of cord or root pressure immediately following the accident, paralysis may develop as a result of treatment, a circumstance experienced by Rogers[6] in four of seventy cases of fracture and dislocation of the thoracic and lumbar vertebral bodies.

Since the four cases in which cord involvement followed manipulation showed either a crushing fracture of the posterior wall of the vertebral body or fracture dislocation, Rogers divides his cases from the standpoint of cord hazard into two groups: the safe and the dangerous. In the safe group he includes all vertebral body fractures which do not involve the posterior wall of the centrum, probably over 90 per cent. The dangerous group includes all dislocations and all fractures involving the posterior wall of the centrum.

In the case reported by Rogers[6] in which open surgical reduction was performed there had been little or no evidence of root pressure for a day after the accident. "Slowly spreading paralysis then developed in scattered groups in both lower extremities. On the third day during an attempt to effect extension by the usual method of using ankle traction and suspension with block and tackle supplemented by manual traction, the paralysis quickly changed to complete paralysis. Open reduction under local anesthesia was done the same day.

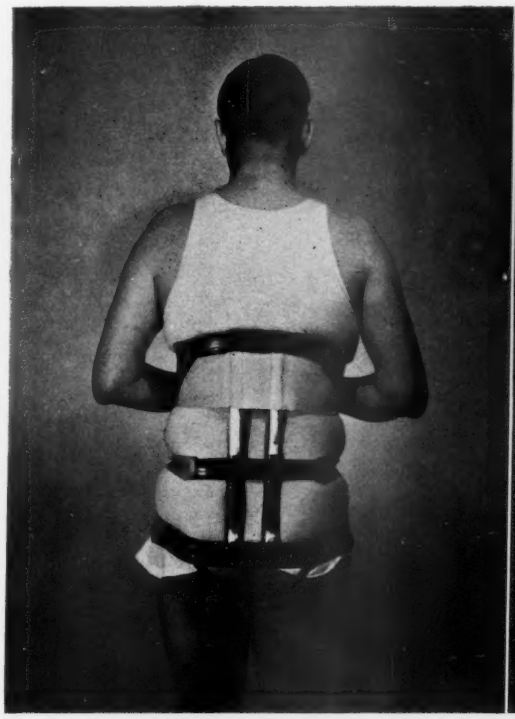

Fig. 6a. A. C., back brace being worn, nine months after operation.

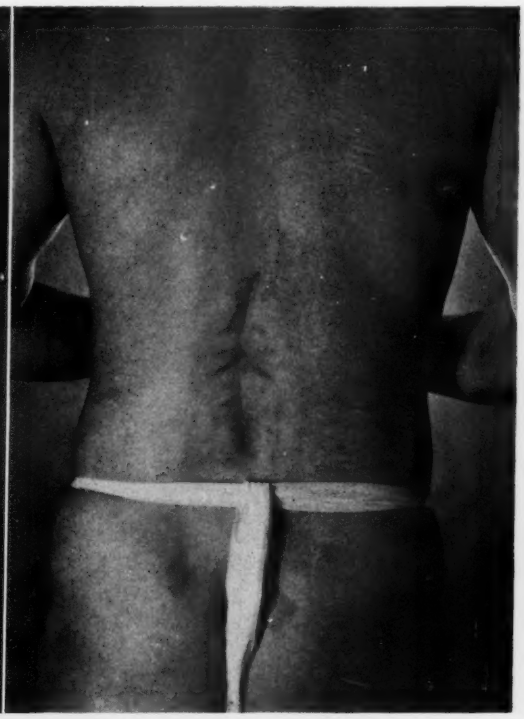

Fig. 6b. A. C., position and condition of operative incision nine months after surgical reduction of fracture dislocation.

Fig. 6c. A. C., degree of forward bending of the spine possible nine months after surgical reduction of fracture dislocation.

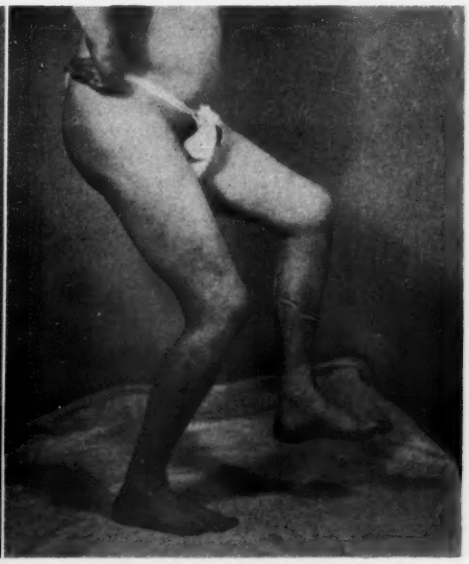

Fig. 6d. A. C., nine months after surgical reduction of fracture dislocation; muscular power of right leg, though still weak, can support body weight when knee is flexed.

One year later all neurological signs had cleared up, the patient was symptom free and able to engage in full pre-injury activities."

gave but a temporary feeling of success, however, since roentgenograms made the following day (Figs. 4A and 4B) showed that although the compression fracture of

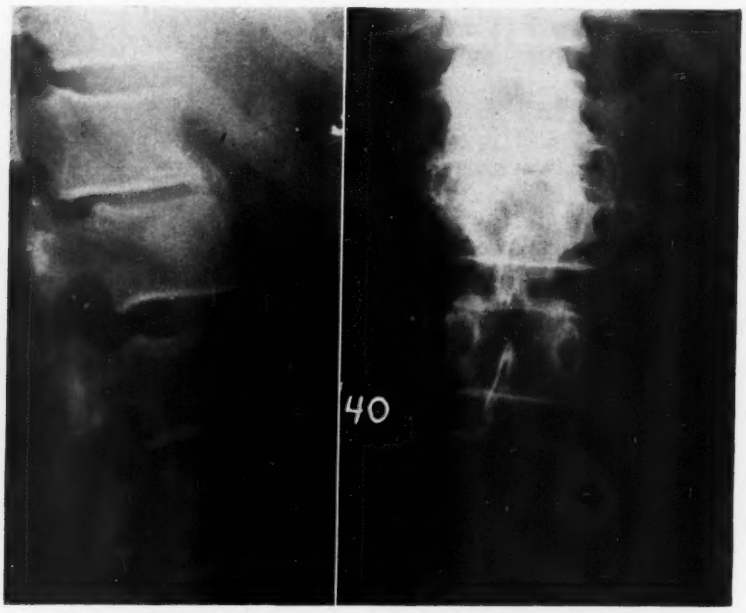

FIG. 7A. Lateral view.

FIG. 7B. Anteroposterior roentgenogram of lumbar spine of A. C., May 31, 1940, to show condition and position of L 1 and 2 nine months after open surgical reduction of fracture dislocation.

In the case of A. C., whose record forms the basis of this communication, damage to the spinal contents at the time of the accident was evident on admission to the hospital. During the subsequent four hours the paralysis gradually extended to involve both lower extremities. Except for a sensation of coldness, the right leg became completely paralyzed, the right half of the peroneum anesthetic. Hypesthesia in the left inguinal region of the front of the left knee and on the dorsum of the left foot was also noted.

Circumstances were most unfavorable for open reduction at this time, but the need for relief was imminent. An attempt by the usual method of ankle traction and manipulation, a few hours after the injury, resulted in a complete disappearance of all external evidence of the deformity. The symptomatic relief which also followed

the body of the second lumbar vertebra as well as the forward displacement of the upper on the lower segment had been favorably affected by the procedure, (Fig. 4A) the lateral dislocation had become securely locked by a change which had occurred in the positions of the articular processes of the involved vertebrae. (Fig. 4B.)

Even though the attempt at closed reduction failed in complete restitution of the displaced parts (Figs. 12A and 12B), the symptomatic relief thus obtained did permit an extension of time to procure more favorable conditions for open reduction nine days after the injury.

Although recovery cannot yet be considered as complete, since there is still some weakness evident in the lower left abdominal muscles as well as areas of hypesthesia in the left inguinal region of the front of the

left knee and of the medial four toes, the patient resumed practically all of his pre-injury activities within the year following his injury.

CONCLUSIONS

1. A favorable outcome can be expected from open surgical reduction of fracture dislocation of the lumbar spine with cord or cauda involvement if the injury to the spinal contents has not been so great as to cause irrecoverable cord damage.

2. Complete reduction affords the best chance for satisfactory recovery even in those cases in which the damage to the spinal contents appears to be extensive.

3. Careful consideration should be given to the condition of the articular processes of the involved vertebrae in all fracture and fracture dislocations of the thoracic and lumbar spine. If the processes are locked in a dislocated position, open operative reduction should be done as soon as the patient's condition will permit doing so with safety.

4. If it is apparent that the articular processes might lock on extension, great care must be exercised in any attempt at closed reduction, and should not be resorted to except when the need for reduction is imminent and circumstances will not permit open reduction.

5. Even when no evidence of cord or root pressure is present immediately following the accident, the development of paralysis, either immediate or delayed, in the dangerous cases[6] can be avoided by open reduction.

6. It is conceivable that the removal of one or more of the involved articular processes may be necessary to facilitate reduction, but their retention when practical should aid in the stability of the parts once reduction is accomplished.

7. Because of extensive damage to soft structures which normally retain the vertebrae in position, measures to prevent redislocation, particularly the slipping backward of the upper on the lower spinal segment, should be instituted and continued until healing is secure. In the case here reported a piece of surgical wire passed through the spinous processes together with a posterior shell proved practically adequate for this purpose, but did permit some displacement as evidenced by the roentgenograms. (Figs. 12A and 12B.) (A strong absorbable suture and a well applied body cast may have served better to prevent the slight redislocation which did occur; this would also have avoided the additional operation for the removal of the wire suture.)

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PAPILLARY CYSTADENOCARCINOMA OF THE OVARY*

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EPHRIAM McDOWELL opened the field of abdominal surgery when he removed an ovarian tumor from a woman in 1809. This was done on the kitchen table in his home at Danville, Kentucky. Since this notable operation, there have been many abdominal explorations in which the chief object has been to investigate and remove, if possible, tumors of the ovary. There are numerous types or kinds of such tumors and many different ways of classifying these new growths, but this paper is to consider only one tumor of the ovary, namely, the papillary cystadenocarcinoma. This term is a descriptive one used by the majority of men in referring to this type of tumor and is perhaps the best known of the names for it. As used in this paper it includes the papillary adenocarcinoma and the carcinomatous cystadenoma, papillary and mixed, of Broder's classification as listed by Counseller and Desjardins.[11]

It is not the purpose of this paper to reclassify this tumor or to try to fit it into any one of the numerous classifications of ovarian tumors. It is, rather, purposed to discuss papillary cystadenocarcinoma of the ovary, stressing in particular the treatment.

For the purpose of investigation and study, the records of the Guthrie Clinic and Robert Packer Hospital have been used, going back to June 1, 1927. There have been thirty cases of papillary cystadenocarcinoma which can be used in this study. Only those cases are reviewed in which there was a definite pathological diagnosis made on evidence as shown by operation or necropsy including microscopic verification. There were other cases in the files with a clinical diagnosis of papillary cystadenocarcinoma which lacked pathological diagnosis because they had not as yet come to operation or necropsy. For this reason they were not included in the present series.

ETIOLOGICAL FACTORS

Papillary cystadenocarcinoma of the ovary arises from epithelial structures found within the ovary. Goodall[15] has shown that the ovary contains many of these epithelial structures, all of which are derived from a common source—the germinal epithelium. Counseller[9] speaks of these as undeveloped cells and embryonic rests, showing that they arise from the surface of the ovary. Because nothing in the human body can equal the metaplastic powers of the germinal epithelium and because the ovary undergoes numerous physical changes from puberty to the menopause, it is not hard to understand why it is such a common seat of malignant change. However, it is more difficult to understand in some cases why it assumes the papillary type of growth with which we are interested in this paper.

Taylor[36] in a study of malignant tumors of the ovary, describes two methods for the formation of the papillary growths. The first is a simple sprouting of the epithelium which carries connective tissue and blood supply with it. The second method is by the formation of multiple glands which dilate until the partitions rupture. Broken ends thus form projecting papillae. The first may be of any size and usually has a cauliflower-like appearance with a small base or pedicle. It is this type which projects on the surface of the tumor in some

* Cases taken from the records of the Guthrie Clinic and Robert Packer Hospital, Sayre, Pennsylvania.

cases. The second is more strand-like and is usually found on the inside of the tumor.

Bernstein,[3] in a study of over 1,000 cases of operations for ovarian tumors, has shown that papillary cystadenocarcinoma is the most frequent type of malignancy of the ovary. In general this agrees with the observations of other workers although his figure of 85.5 per cent is much higher than that found in the other groups of cases. Bernstein[3] shows that of all new growths of the ovary, benign and malignant, 15 per cent are papillary cystadenocarcinoma. Taylor[36] says that approximately one-half of all serous epithelial tumors of the ovary are papillary in nature and one-half of these are malignant.

In 245 cases of papillary cystadenocarcinoma, Moench[25] found the average age to be 46.9 years; in his series the oldest was seventy-three years and the youngest sixteen years. Only twenty-nine of his group were single but of the married women there were seventy-three who had no children so that the nonparous group totaled 102 patients or 40.2 per cent and the parous group 152 or 59.8 per cent. These figures may well be taken as representative of this type of tumor. Bell, Blair, and Datnow[2] also showed that the majority occur in parous women. They group the largest number of ovarian neoplasms between the ages of twenty-four and fifty years and speak of this as the "period of reproductive involution." It is at this time in life that there is perhaps the most marked change in the structure and function of the ovaries. If the metaplastic powers of the epithelium are going to manifest themselves by producing a new growth, it would be most likely to come at this period. In the thirty case histories reviewed here, it was found that the ages vary vetween thirty-one and seventy-seven with an average age of 52.9 years. Table 1 shows the grouping of these.

Many have said that there is no definite relation between carcinoma of the ovary and other carcinomas. While it is true that there may be two lesions, both malignant, in one individual, this does not often occur. It is interesting that in this small group of thirty cases there were five patients or 16.6 per cent who either had or have had a carcinomatous lesion elsewhere in the body. There were three cases with carcinoma of the breast. Two of these patients had the breast lesion at the time the ovarian pathology was found. The other patient had had a radical mastectomy for carcinoma five and one-half years previous to the finding of the pelvic pathology. Of the other two patients with carcinoma elsewhere, one had had surgery for "carcinoma of the bowel" seventeen years previous and in the other an adenocarcinoma of the rectum was discovered one month after operation for the papillary cystadenocarcinoma. In spite of the presence of three breast carcinomas in this group it is believed that there is no relation between papillary cystadenocarcinoma of the ovary and carcinoma of the breast.

Table 1
AGE GROUPS

Ages Years	Number	Per Cent of Total
30–39 incl.	3	10
40–49 incl.	5	16.6
50–59 incl.	15	50
60–69 incl.	5	16.6
70–79 incl.	2	6.6

Racial incidence seems to point to the greatest number of these cases being in the white race but no definite figures were found to substantiate it. All of the cases in this Clinic were in white females but the area from which the patients were drawn has a much smaller colored population than many other areas.

SYMPTOMS

The complaints of these patients are mild and insidious in onset. It is for this reason that so often the patients are first seen in a late stage of the disease. Were the symptoms more severe or were there more definite changes in the menstrual periods of

these patients, a larger number would seek medical care earlier. The earlier it is diagnosed, the better the prognosis because the condition is more likely to be operable.

It is startling to find that a tumor as large and as rapidly growing as papillary cystadenocarcinoma does not produce more symptoms. The rapidity of growth and the fact that it is a fairly movable tumor occurring in the abdomen of the female, which physiologically is capable of taking care of an enlargement of the pelvic organs as in pregnancy, may have some bearing on the comparative lack of symptoms. Then again it is true in general that until far advanced, a carcinoma may not have many symptoms. However, with a tumor of an organ so intimately connected with menstruation, one might expect more of a change in the menstrual history.

The majority of patients, when first seen, will complain of lower abdominal distress. It is usually unilateral but may be in the midline or bilateral. While in most patients the pain is not severe, there are a few who complain of a severe, sharp stabbing pain. Moench[25] stated that 52 per cent have pain of some type and that it is the most common symptom of which the patient speaks. Bernstein[3] found that 65 per cent of patients complain of some type or degree of abdominal distress and speak of the pain as fairly constant but mild, being not as common in carcinomatous as in benign growths of the ovary. The pain is due to general abdominal pressure, change in the ovary itself and interference of the blood supply but may be caused by pressure of the new growth on other organs and by the pull of adhesions. Adams[1] found that acute pain is usually associated with torsion, necrosis or rupture. In more advanced cases the pain can often be attributed to peritoneal irritation.

In the case histories reviewed in this Clinic, it has been found that 66 per cent of patients had some type of abdominal pain. Some patients did not at any time have even the slightest distress in the abdomen but came for other symptoms such as swelling and fullness or because they had noted enlargement of the abdomen.

In some of the patients the interference with ovarian function is indicated by a change in the regularity or amount of menstrual bleeding, but when present these changes are usually slight. After the menopause there may be a small amount of bleeding or spotting at irregular intervals. Metrorrhagia is present in only a few patients. Because such a large number of patients are beyond the menopause, the percentage of irregularity of menstrual bleeding is much smaller than were one to compute statistics only on those who are premenopausal. In this series of cases there were twenty-three postmenopausal patients and only seven premenopausal. Fifty-seven per cent of the seven in the premenopause group showed irregularity but this is only 13.3 per cent of the whole group. On the other hand there were 30.4 per cent of the postmenopausal group who showed some evidence of bleeding again; this is 23.3 per cent of the series. Altogether one-third of the patients complained of irregularity or spotting. Berstein[3] found only 4 per cent of papillary cystadenocarcinoma to have spotting or bleeding after the menopause.

TABLE II
MENSTRUAL CHANGES—IRREGULARITY OR SPOTTING

Group	No. Cases	No. Showing Changes	Per Cent of Group	Per Cent of Total Cases
Premenopause....	7	4	57.0	13.3
Postmenopause...	23	7	30.4	23.3
Total cases.....	30	11	....	36.6

When first looking over these cases the age of onset of menstruation was thought to be of some possible significance. However, it was later found that the average age of onset was 13.7 years. Only two began menstruating after the age of fifteen years. Lynch,[24] in making a study of ovarian cancers, found that 30 per cent of ninety-two patients with carcinoma of the ovary

did not begin to menstruate until fifteen years or later. The average age in his group was 13.9 years. He studied normals in gynecologic patients by taking nine groups of 100 cases each and found that from 15 to 35 per cent of the patients began menstruating at fifteen years or later. The average for the nine groups (900 patients) was approximately 28 per cent starting at fifteen years or later. With these normals in mind one cannot attach any significance to the age of onset of menstruation.

Backache is a rather common symptom but is so common in many of the pelvic disorders of women that no clinical significance can be given to it. Those patients in whom there is considerable enlargement of one or both ovaries seem to have more of this discomfort than the other patients.

Some patients may have been conscious of a mass for weeks but had not sought relief until a more sudden diffuse abdominal enlargement was noticed. The onset of metastasis can often be judged by this sudden enlargement of the abdomen due to ascites. Because of its significance, it is only too frequently found. However, not all patients with fluid will have metastases to the peritoneum, nor will all patients with metastases show fluid in the abdomen.

The weights of the patients in this series were not recorded in all instances nor was a change of weight mentioned frequently. In seven patients there was a definite history of weight loss but this was late in the course of the disease as shown by operation. Associated with the weight changes was some degree of general malaise and ill feeling.

Other symptoms such as bladder irritation and respiratory complaints are infrequently seen. These can usually be attributed to direct pressure by the tumor mass as it enlarges or by the general abdominal pressure of ascites. The bladder symptoms of dysuria, frequently and urgency are usually mild.

Gastric symptoms such as anorexia, nausea and vomiting occasionally do occur. The anorexia usually accompanies the malaise and other general symptoms.

FINDINGS AND DIAGNOSIS

The findings on physical examination associated with the history and the symptoms will lead one to make a diagnosis of carcinoma of the ovary. However, the distinction between papillary cystadenocarcinoma and other malignancies may be more difficult. All malignancies of the ovary are not as rapidly growing as is this condition. A rapidly growing tumor with a short history associated with bilateral involvement and ascites might well be diagnosed as papillary cystadenocarcinoma.

There will usually be a palpable, somewhat tender mass in one or both lower quadrants on abdominal examination. On vaginal examination, the occurrence of a mass is constant. It is usually found separated from the uterus and in early cases is movable, later becoming fixed. It may be smooth and rounded but most commonly is nodular and irregular. It rises well up out of the pelvis to a level of the umbilicus or above. Often the involvement is bilateral. A very early involvement and one which is not frequently seen may show a little enlargement of only one ovary. Occasionally, one will find a generalized carcinomatosis with the pelvis filled with a large fixed mass in which no organs are definitely palpable. In these cases there is usually a great deal of omental and peritoneal involvement and nodules can be felt throughout the abdomen. The uterus in the average case is unchanged except for some displacement. Of the histories reviewed in this Clinic 100 per cent showed some degree of pelvic mass either on pelvic or abdominal examination or both.

In the majority of cases there was evidence on examination of bilateral involvement yet in a few of these it was found at operation that the one ovary had extended across the midline, the other not being grossly involved. Vaginal examination often clears up unusual abdominal findings. Clinically, one cannot always say that there is or is not bilateral involvement. Postoperative examination of the clinically uninvolved ovary will often reveal small

papillomas, microscopically demonstrating malignant cells.

Ascites will often mask the findings on abdominal palpation and make the pelvic structures hard to feel on vaginal examination. When present in association with a pelvic mass, it points quite definitely to malignancy with peritoneal metastasis. Boyd[5] points out that bloody ascitic fluid in a female should always suggest the possibility of carcinoma of the ovary. Abdominal paracentesis should be done so as to picture more clearly by palpation the condition of the pelvic organ. A specimen of the ascitic fluid should be sent to the laboratory for microscopic study. A positive diagnosis of malignancy is made if the malignant cells are found in the centrifuged specimen. When present they rule out ascites of nephritis, hepatitis or cardiac failure.[7]

Peritoneoscopy may prove to be of some value in diagnosing obscure cases in which the patient either refuses surgery or is in no condition to stand an operative procedure. In some selected cases it could be used to determine the advisability of roentgenotherapy before a major surgical procedure. Ruddock[32,33] made the diagnosis forty-four times in a series of 900 peritoneoscopies done for various conditions.

Other findings and studies are of little additional help except to inform the examiner of the exact physical condition of the patient. The blood count is practically unaltered except for a frequent elevation of the leukocytes. In those patients giving a history of malaise and loss of weight there is usually a moderate degree of secondary anemia. Norris and Vogt[29] summarize the important symptoms of malignancy as ascites, rapidity of growth, bilateral involvement (50 per cent), fixation of the mass, nodular feel and general symptoms of loss of weight, anorexia and cachexia.

Frost[14] has reported the case of a patient in whom there was found a generalized carcinomatosis but no primary lesion could be demonstrated until eventually a growth in the pelvis became distinct and the diagnosis of papillary cystadenocarcinoma was made and later proved by necropsy. Usually, however, the primary lesion is detected even in the presence of metastasis.

PATHOLOGY

This lesion represents one in which there may be varying degrees of malignancy. Most pathologists agree that some types of papillary cysts of the ovary are not malignant. Again it is not the purpose of this paper to go into detail on the discussion of this point. All the cases reviewed are malignant papillary growths. However, various authors believe that those growths which appear to be benign will also contain some malignant tissue. If it were possible to make serial sections of all these tumors and study them carefully, there would be a larger number of the seemingly benign growths which would be found to be malignant. Taylor[36] says that ovarian cysts, even when believed to be benign, must be tentatively regarded as precancerous and removed as soon as possible, for papillary processes may be on the inside or on the point of developing. Counseller and Desjardins[11] in a review of all adnexal cysts and neoplasms state that "if the cyst [cystadenoma of the ovary] contains papillary growths, it is definitely malignant." Hawk[16] is of the same opinion. Norris and Vogt[29] state that "of benign tumors a definite proportion, particularly of the cystadenoma, would have become carcinomatous if removal had not been undertaken."

Papillary cystadenocarcinoma grows rapidly and metastasizes early. It is much more likely to be bilateral than any other ovarian tumor. Pfanenstiel, as quoted by Taylor[36] says that 66 per cent of papillary malignant tumors are bilateral. Prentice[31] suggested that the contralateral ovary should be examined in every case of papillary cystadenocarcinoma for it is known that different grades of malignancy may be found on the two sides when two cysts are present. In this Clinic it was found that 53.3 per cent of patients had a bilateral involvement.

Grossly, the tumor may have a rough or smooth surface which is multicolored, usually of a pinkish-grey color but it may be whitish, reddish or yellowish exhibiting a wide range of histologic structure. Single tumors vary from adenomatous to almost solid and often mucinous[34] tumors but all show papillary growths at some point. The papillomas may project from the surface or on the inside of the tumor. When on the surface, they give a rough appearance to this portion of the tumor. In type, they may be either a simple papilloma or friable, cauliflower-like and easily broken off. The papillomas often are not noted until the tumor is sectioned.

Table III
side of involvement

Side	Number	Per Cent of Total
Right	10	33.3
Left	4	13.3
Bilateral	16	53.3

The cyst contains fluid or mucinous material, usually of a clear straw color but may be darker and more like the chocolate cysts. These cysts enlarge rapidly soon becoming so large and so fixed as to be inoperable, the tendency to attach early to adjacent structures leading to the difficulty of operative removal. Early metastasis is the rule. According to Codman[8] this occurs when terminal cells drop off and seed the peritoneum. The process may be speeded up by trauma which ruptures the cyst, spreading large numbers of cells throughout the whole peritoneal cavity. Intestinal peristalsis may also do this.[7] Bell and Datnow[2] have demonstrated that even adhesions may carry out malignant cells to other structures.

The usual sites of metastasis are to the opposite ovary and adjacent organs; metastasis to distant organs is rare. Stout[35] says that there is metastasis, peritoneal or distant, in 90 per cent of cases, late metastasis being the exception and not the rule. He has found supraclavicular nodes with metastasis fifteen years after removal of both involved ovaries, metastasis in the spleen twenty-five years after and in the omentum sixteen years after. In addition he has found metastasis in liver, lung and stomach. Other authors have demonstrated metastasis in paravertebral nodes, axillary nodes and ribs as well as other bones. Bernstein[3] pointed out that approximately 50 per cent of papillary cystadenocarcinoma invade the gastrointestinal tract, 60 per cent the peritoneum and 35 per cent the gynecological tract. He stated further that 75 per cent have already invaded secondary structures before surgery.

Recurrence of papillary cystadenocarcinoma is common. Ewing[13] shows that this occurs in 83.3 per cent of cases. Ascites is common and follows peritoneal irritation. About 60 per cent of patients will show ascites in a large series of cases. In the group reviewed from this Clinic there were nine, or 30 per cent, who had clinical evidence of ascites.

Following roentgenotherapy in inoperable cases the tumor is usually found to be decreased in size though not greatly changed in appearance. It tends to be more friable in character and lacks the large cystic areas, although the cystic nature of these tumors is still easily recognized.

Microscopically, these tumors of the ovary present the usual picture of malignancy. At times the definite papillary structure can be seen on the slide by low power as an irregularly proliferating papilla lined by an atypical epithelium which in places consists of several layers.[12] (Fig. 1.) More often the papillary nature is not seen on the slide because of the area in the tumor from which the section is taken or because the papillae are so large they can be sectioned only in part. Under high power magnification the atypical arrangement is more evident and there is no regularity of the cell layers. As in any malignant specimen, mitotic figures will usually be seen. Because it is hard to see the papillary nature from the single slide, one must also depend upon

the gross findings to make the pathological diagnosis. It is well to stress that, with malignancy, cells from ascitic fluid must be stated, these tumors grow rapidly and unfortunately the patient often comes so late in the course of the disease that the condi-

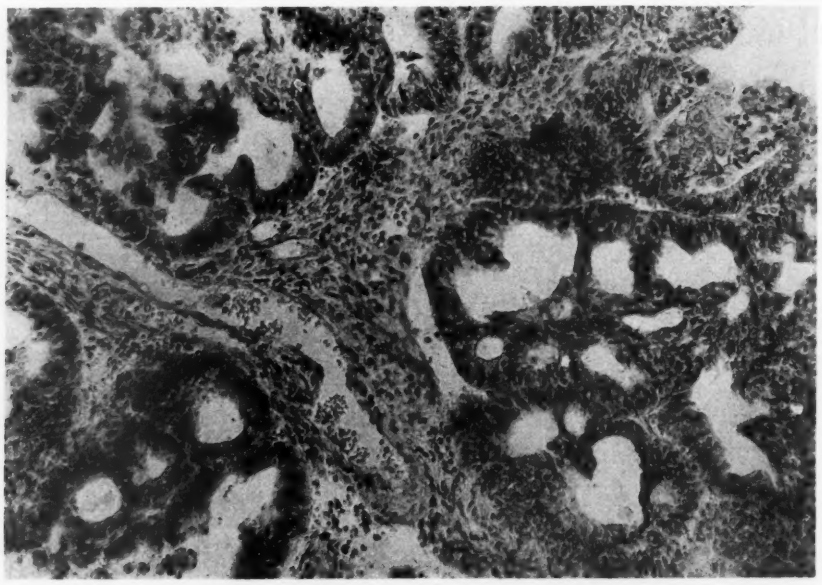

FIG. 1. Case v. Papillary cystadenocarcinoma. Section from ovary showing typical papillary structure. × 175.

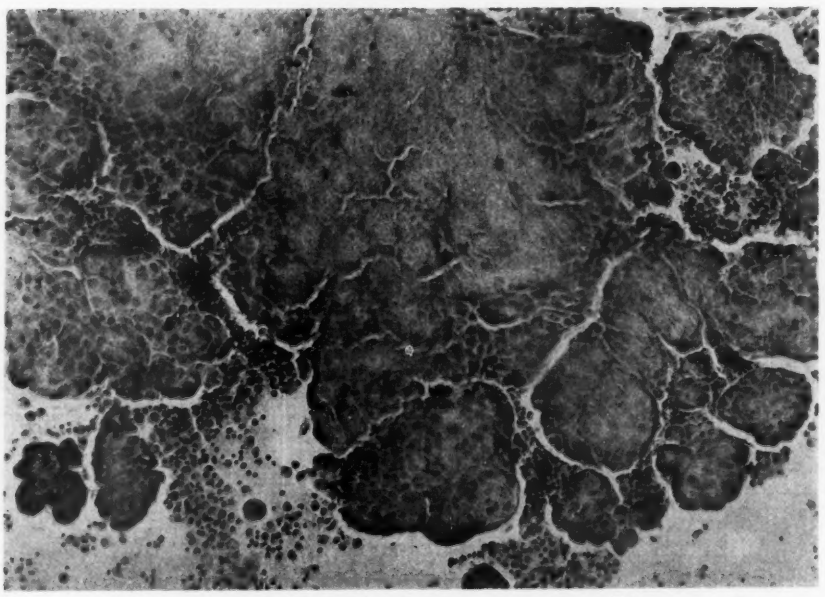

FIG. 2. Case IV. Ascitic fluid obtained from a case of papillary cystadenocarcinoma showing group of papillary carcinoma cells. × 175.

in groups; otherwise they may be confused with epithelial cells. (Fig. 2.)

TREATMENT

As in the majority of new growths the ideal treatment of this condition is early removal before metastasis and direct spread have taken place; but, as has already been tion is already inoperable. The problem then is to do the most that is possible for the patient.

The treatment in this Clinic is in general the same as that followed in many other clinics and by various individuals. An abdominal exploration is done in the case of a patient who is believed to be operable

when first seen. All the pelvic generative organs are removed with the tumor if possible. Following healing of the operative site, the patient is given a course of roentgenotherapy.

In the case which proves to be inoperable at the time of exploration the abdomen is closed and roentgenotherapy started as soon as healing takes place. If good results are noted due to the radiation and the size of the mass decreases, this patient is subjected to a second laparotomy. Following this, another course of roentgenotherapy is given.

If the tumor is considered inoperable on clinical examination, an attempt is made to secure from ascitic fluid (if present) enough sediment to examine for malignant cells to confirm the clinical diagnosis of malignancy. In these patients roentgenotherapy is used first and an operation planned for a later date if the results are satisfactory. Here again a second course of therapy is given following the operation. It is believed that all cases of papillary cystadenocarcinoma of the ovary should have the benefit of radiation.

Other factors preventing surgery are marked cachexia or complications which might endanger the life of the patient on the operating table or during the postoperative convalescent period. With the use of safer anesthetics administered by skilled anesthetists, the number of patients in this group is greatly reduced and more of them can be safely operated upon.

As stated before, all the pelvic generative organs should be removed. At the time of operation a frozen section is made and studied so that the diagnosis is certain before the abdomen is closed. Taylor[36] advises hysterectomy with removal of both tubes and ovaries even though only one side is visibly involved. He also stresses postoperative radiation and says it should never be omitted in any malignant case and that in moderately advanced inoperable cases it may render them operable. Counseller[9] recommends that because of the high incidence of bilateral involvement all the generative organs should be removed. Kaplan[19] found that the best results are achieved by roentgenotherapy followed by operative removal of the bulk of the tumor and then followed by another course of roentgenotherapy. Murphy[27] urges a judicial use of a combination of surgery and radiation and recommends that ovaries, tubes, broad ligaments and the uterus be removed even in the reproductive period of life. Blair, Bell and Datnow[2] do a total hysterectomy in parous women and a subtotal in the nonparous women and believe that it is disastrous to remove only the one affected ovary and leave in the other ovary, tubes and uterus. Keene,[20] Widmann,[37] Jacobs,[17] and Jacobs and Stenstrom[18] all believe that radiation is justified either after, or before and after operation.

Counseller and Desjardins[11] recommend 2,500 to 3,000 roentgen units through each of four portals or 10,000 to 12,000 units for a total dose. At the University Hospital in Philadelphia the dosage has been given at 200 kilovolts and four milliamperes at a 50 cm. focal skin distance with 0.5 mm. of copper and 2 mm. of aluminum, each treatment lasting from 75 to 100 minutes.

In this Clinic radiation is given at 200 kilovolts and 25 milliamperes, at a 50 cm. focal skin distance with 1 mm. each of copper and aluminum filtration. Approximately 300 roentgen units are given at each treatment. The exact total dosage is determined by the findings in each individual case and by the changes noted or results obtained with this therapy. The average case will receive from 4,000 to 6,000 units or more over a two to four weeks' period.

Treatments are given through four or six portals, four anterior in the four abdominal quadrants and two posterior. The pelvis usually receives the greatest amount of radiation through two anterior and two posterior portals; but if there is extensive upper abdominal metastasis, the two upper portals will receive proportionately more therapy. The portals used are 15 by 15 cm. in size for the average patient but may be varied according to the size of the indi-

vidual. Jacobs and Stanstrom[18] use fields of 350 to 500 sq. cm. anteriorly from the symphisis to the xyphoid and 200 to 300 sq. cm. posteriorly from the coccyx to the last rib.

Treatments here are given over a number of days and in the small daily dosage of 300 roentgen units, as it has been found by roentgenologists that this is less conducive to radiation sickness. Elixir of phenobarbital as a sedative three times a day will go far in combating this sickness if it occurs.

Radiation is begun about two to three weeks after operation, the operative site being well healed, or immediately after diagnosis has been established if no operative procedure is undertaken. During the series of treatments the white blood count should be closely watched though there is seldom an alarming change resulting from this type of treatment.

Keene and Pancoast[21] believe that it is impossible to predict the effect of radiation in any given patient. Some of the most hopeless cases with little radiation will clear up surprisingly while other much less advanced cases may not be appreciably affected by an enormous dosage. They feel that the peritoneal metastases are more sensitive to radiation if the primary growth has been removed. Bevan[4] says that "as a rule of course, in these ruptured papilloma with peritoneal implants, *x*-ray therapy is not successful and the patient goes on to fatal termination." Others find that often there are good results shown by decrease in the size of metastatic nodules and less rapid formation of ascitic fluid. It is true, too, that at times the metastatic nodules will disappear after removal of the primary tumor even without radiation.

Stewart[34] finds that lower grades of malignancy in papillary cystadenocarcinoma yield better results after radiation. Perry[30] states that if ground is gained slowly, the effect is more lasting than in those cases with rapid and startling early progress following radiation.

Patients in this Clinic who have had roentgenotherapy before operation are followed closely and examined frequently so that removal of the tumor may be attempted at the most satisfactory time during the patient's response to therapy. When ascites is present, abdominal paracentesis is done as frequently as necessary. The general physical condition of the patient is also closely checked and improved as much as possible. Transfusion is given if there is much lowering of the hemoglobin and red blood cell count. Other more general methods are used to build up the health of the patient.

PROGNOSIS

As with any highly malignant lesion the prognosis in papillary cystadenocarcinoma is extremely guarded; it is usually fair if the primary or parent growth is removed. Counseller[9,10] believes that 50 per cent survive five years after panhysterectomy with radiation and deep roentgenotherapy. Moench[25] found in 231 cases traced three years or more after operation that there were 27.1 per cent of deaths and all these were due to abdominal recurrence or distant metastasis. Of the 168 living patients, six had been followed for three years, ninety-seven for five years and sixty-five for ten years. In her series there were only forty-eight cases that showed metastatic growths. Taylor[36] gives the prognosis as being fair if only one ovary is involved when operated upon and more hopeless if both ovaries are diseased. If limited to the removable pelvic organs, 44.1 per cent have a fair chance. Other cases are all hopeless.

Table IV
SURVIVALS AT VARIOUS YEAR PERIODS

Years after Operation	No. Patients	Per Cent of Total
Less than 1	13	43.3
1	17	56.6
2	13	43.3
5	7	23.3
7	5	16.6

We have been able to follow all of our thirty cases reviewed and have examined or

have received a report of examination on all the living patients during the months of October and November, 1939. Tables IV and V show the distribution of the patients after surgery.

TABLE V
YEARS SINCE OPERATION OF 11 LIVING PATIENTS

Years since operation	1	2	3	4	5	6	7	8
Number patients living	1	3	0	1	1	0	3	2

One patient is still living nearly nine years after surgery. All of the cases studied have been proved by observation of the lesion and microscopic study of tissue removed and in each case a diagnosis of papillary cystadenocarcinoma was made. An effort was made to correlate the physical findings at time of examination with the findings at the time of operation and it was found that in almost all cases the lesion was found to be about as one would imagine from the physical examination. However, in several instances the lesion was thought to be unilateral but at operation it was found that there was extension into the other ovary.

CASE REPORTS

The case histories of five of the patients are presented in more detail:

CASE I. A white female aged forty-four years, married for twenty years, primipara and premenopausal, came to the Clinic with the chief complaint of abdominal swelling and a feeling of fullness for ten days. Associated with this was some moderate pain across the lower abdomen, with frequency and nocturia. The menstrual history was negative, the last period occurring two weeks before admission. Routine laboratory studies were normal. Abdominal examination showed only a marked ascites. Vaginal examination revealed a large, nodular, tender, hard, fixed mass in the right adnexa and midline. A diagnosis of papillary cystadenocarcinoma was made but it was believed that the condition was inoperable so that roentgenotherapy was advised as a preoperative measure. A total dose of 7,800 roentgen units was given in twenty-six treatments. During the time of these treatments abdominal paracentesis was performed eleven times. Each time the interval between was longer until toward the end of the treatments the fluid ceased to accumulate. Examination of the pelvis at intervals showed a marked decrease in the size of the tumor in the pelvis although nodules had appeared in the upper abdomen.

Eight months after first being seen in the Clinic an abdominal exploration was performed as it was thought that the condition had now become operable. In the area of the right ovary was a moderately sized, friable mass which was removed with some difficulty. Frozen section at this time showed malignant cells and the papillary nature of the tumor was evident. There was some involvement of the left ovary also and permanent sections of the mass and the left ovary showed papillary cystadenocarcinoma. The operation consisted of bilateral salpingectomy and öophorectomy, subtotal hysterectomy and excision of metastatic growths in the omentum. A large portion of the omentum was removed with these growths.

Two weeks after surgery she was again given roentgenotherapy consisting of a total dose of 6,000 roentgen units in twenty treatments with a proportionate amount to the upper abdomen because of the metastatic growths that had been found there at the time of surgery. Three and one-half months after operation there were still some nodules palpable in the upper abdomen and more roentgenotherapy was advised, 3,180 roentgen units being given through two upper abdominal portals at this time. There was fluid still forming in the abdomen which required draining at intervals until the time of her death at home eight months after surgery.

CASE II. A white female, aged fifty-one years, married for thirty-one years, gravida IV, para IV and five years postmenopausal, came to the Clinic because of a sharp pain in the lower abdomen radiating into the labia. This had continued for six or seven weeks during which time she had also noted a palpable tumor low in the abdomen. She had lost thirty pounds during the previous three months. There had been no postclimacteric spotting or bleeding. Routine laboratory studies were normal except for a slight elevation in the white blood count with a normal differential, and one plus pus cells in the urine. On abdominal examination there was some tenderness across the lower

abdomen and a mass was palpable in the lower right quadrant rising nearly to the level of the umbilicus. On vaginal examination the uterus was felt to be separate from a large mass which filled the right adnexa. This mass was fairly firm and not movable.

Exploratory laparotomy was advised and was performed two days after admission. At operation there was found a large fixed ovarian cyst on the right side with metastatic papillary areas in the peritoneum, the small bowel was adherent and the mass itself was fixed to the posterior wall. A biopsy was taken and the abdomen closed. Frozen and permanent sections showed a papillary cystadenocarcinoma, grade III. Roentgenotherapy was started after healing of the abdominal wound and a course of twenty treatments were given with a total of 6,000 roentgen units. There were four treatments to each of four pelvic portals (two anterior and two posterior, 15 by 15 cm.) and two treatments to each of two anterior upper abdominal portals. During the last stages of treatment fluid began to collect in the abdomen requiring abdominal paracentesis six times at ten day intervals removing from four to eight liters each time. The fluid gradually became more reddish and cloudy. During these two months the general condition of the patient became worse and she died seven months after first being seen. A necropsy was not obtained.

Case III. A white female, aged fifty-five years, married for thirty-seven years, gravida VI and para VI, and eight years postmenopausal, came to the Clinic because of protruding abdomen which had become larger during the preceding year. The family physician had noted a tumor in the abdomen. She had noted no spotting or bleeding since the menopause. Routine laboratory studies, (urine and blood counts) were normal and the Wassermann test was negative. On examination she had some moderate tenderness over a large lower abdominal mass extending up to the costal margin on the left side. No ascites was noted. Pelvic examination revealed an immovable mass filling the entire pelvis and extending up into the abdomen. The uterus was small and posterior.

Three days after admission an exploratory laparotomy was performed and a biopsy was taken from this irregular mass which was found to be rising from the pelvis and extending upward in the root of the mesentery. Permanent section of the tissue removed showed a papillary cystadenocarcinoma of the ovary, grade III. Roentgenotherapy was instituted when she had recovered from the operation. Through four abdominal portals, 3,600 roentgen units were given; 1,200 r to each lower quadrant and 600 r to each upper quadrant. Three months later this patient returned for examination. No masses were found and the uterus was movable. Seven months after operation and roentgenotherapy, the pelvis was found to be free of any mass.

One year after operation she returned with symptoms of a transverse myelitis that was thought to be metastatic. She died shortly after coming into the hospital and necropsy was done but no tumor was found in the spine. There were some small metastatic lesions throughout the mesentery but no large masses were found and the ovaries were small and hard.

Case IV. A white female, aged sixty-nine years, married, gravida IX, para VII, and 29 years postmenopausal, presented herself because of swelling in the abdomen over a period of four to five months. In the previous two weeks the swelling had been more marked and more rapid. She had had no postclimacteric spotting or bleeding until one week before admission when she had noticed a small amount of bloody discharge. During the preceding two weeks she had experienced some lower right quadrant pain of a bearing down nature. Routine laboratory studies were negative. On abdominal examination there was evidence of ascites and a palpable, irregular, rather firm. almost fixed mass in the lower right quadrant. On vaginal examination the uterus and a separate right adnexal mass were fixed.

Abdominal paracentesis was performed the day after admission and four liters of clear, straw-colored fluid were removed, making the mass more distinctly outlined. Microscopic study of a specimen of this centrifuged fluid showed malignant cells in groups. Roentgenotherapy was begun and she received 8,320 roentgen units in twenty treatments through six portals, four anterior and two posterior (15 by 15 cm.). Two months after first being seen in this Clinic and five weeks after the roentgen treatments had been completed, the physical examination showed that the condition was probably operable. Exploratory laparotomy showed both ovaries to be involved. The right was a reddish friable mass and the

left was cystic. There were adhesions to the intestines and a few small metastatic nodules in the peritoneum. Frozen section showed malig-

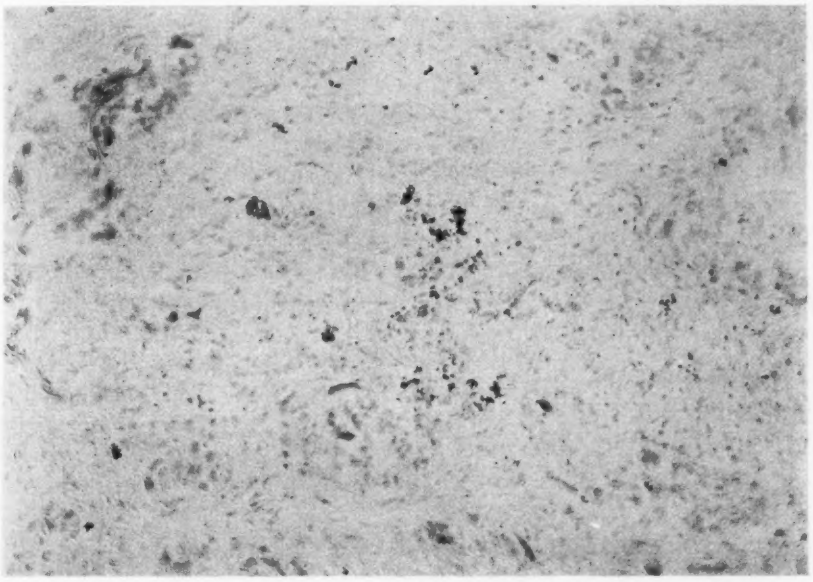

Fig. 3. Case iv. Papillary cystadenocarcinoma. Sections from ovary following roentgen theray showing fibrosis with degeneration of cancer cells. × 175.

nant cells. A bilateral salpingo-öophorectomy was performed but it was impossible to remove the uterus with safety. Permanent sections of the ovaries showed papillary cystadenocarcinoma. Two weeks after surgery another course of therapy was given consisting of a total cinoma. Two weeks after surgery another dose of 4,635 roentgen units in sixteen treatments. Four months after the operation she returned with evidence of ascites. After removing five liters of fluid the pelvic examination revealed some fixity of the uterus but no definite mass was felt; however, the course was generally downward and the patient died with recurrence of the lesion five months after surgery.

Case v. A white female, aged fifty-nine years, single, nullipara, and fifteen years postmenopausal, presented herself in this Clinic because of a dragging down sensation with pain across the upper abdomen for some months. For four months she had had a rather sharp cramp-like pain in the lower left quadrant and some weight loss although the definite amount was not determined. She had noticed no spotting or bleeding since the menopause. Routine laboratory studies were normal. On abdominal examination moderate tenderness in the midline and lower left quadrant was noted. Vaginal examination revealed a large, irregular, movable mass in the left side. Physical examination was otherwise essentially negative. It was believed that this patient had an ovarian cyst which was possibly malignant.

Surgery was advised and at the time of operation a large cyst of the left ovary was removed. There had been perforation of this and a low grade peritonitis was observed, believed to be due to the content of the cyst. The operation consisted of a bilateral salpingo-öophorectomy and secondary appendectomy. The specimen of the ovary showed a multilocular appearance with many papillary growths. Microscopic study of a permanent section showed papillary cystadenocarcinoma, grade ii. As soon as the postoperative condition would permit, the patient was given roentgenotherapy. In twelve treatments a total dose of 3,600 roentgen units (900 to each of four abdominal portals, 15 by 15 cm.) was given. Twenty-one months after operation she was again admitted for acute diverticulitis which responded to conservative treatment. At this time there was no evidence of recurrence on abdominal and pelvic examinations.

SUMMARY

The subject of papillary cystadenocarcinoma of the ovary has been considered and the more recent English literature reviewed. Thirty case records have been

studied, five of these being presented in detail.

Papillary cystadenocarcinoma is a malignant tumor which usually metastasizes so early that the condition is far advanced before the patient seeks aid.

The average age at which it occurs is approximately fifty years. It is slightly more common in parous than in nulliparous women.

Pain and a tumor mass are the predominating symptoms and findings. Over 50 per cent are bilateral when treatment is first undertaken. The growth of the tumor is rapid and metastasis is first to the opposite ovary, then to the uterus, peritoneum and other abdominal organs. Recurrence after removal is common.

Malignant cells recovered from the ascitic fluid aid in the diagnosis and also the planning of a proper course of treatment which consists of operative removal followed by roentgenotherapy in the average patient. Surgery should aim to remove all the pelvic generative organs. Radiation should include the entire abdominal cavity. The effect of radiation is not constant in all patients. Following the removal of the primary growth, the secondary growths may disappear of themselves.

The prognosis is extremely poor but should not keep the surgeon from doing all possible to alleviate the patient. Many patients go without recurrence for years after adequate treatment.

Most of the patients from this Clinic that received roentgenotherapy were far advanced at the time of the first examination.

CONCLUSIONS

The number of cases in this series which received roentgenotherapy is too small to draw definite conclusions as to the value of irradiation. However, Case v illustrates what might be classed as a radiation cure. The necropsy findings of Case III show the effect of radiation on these tumors. Necropsy findings in one other case showed the ovaries to be small and fibrotic, the patient having died from another cause. Figure 3 shows a section from a similar ovary.

We find that radiation tends to decrease the size of the tumor to the extent that a previously inoperable tumor may become operable.

In those patients in whom the tumor has spread beyond the one ovary at the time of surgery the prognosis is extremely poor, but if the tumor is still confined to the ovary and there are no papillary growths on the surface, the prognosis is favorable following surgery and irradiation.

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In their earlier stages these growths (ovarian tumors) produce symptoms only when complications arise, i.e., suppuration or twisting of the pedicle. Small, suppurating cysts give practically the same signs as those of a pus tube, and are recognized only at operation or autopsy.

TOTAL HYSTERECTOMY—VAGINAL OR ABDOMINAL?

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NO attempt will be made in this paper to justify the accepted procedure of total hysterectomy. Rather, by a review of the indications, limitations and end results achieved, an attempt will be made to attract renewed interest in the vaginal approach. Because it is either forgotten or ignored in some parts of Europe and the United States it is hoped that this study will not only revive but also increase the scope of this now too little employed operation. It was made from the hospital records of the Rudolfspital of Vienna, Germany, on the service of Dr. Paul Werner, and consists of an analysis of 100 consecutive vaginal and 100 consecutive abdominal total hysterectomies. It does not include either Wertheim or Schauta operations as these cannot be classified as simple total hysterectomies. And although it covers but a relatively small series of cases, its value is enhanced by the fact that these operations were all performed by one man who followed closely a uniform technic.

All of these patients were white. They were drawn from the middle and lower classes in which hard, manual work is the rule and not the exception. Their age distribution is shown in Table I to be nearly alike for both the vaginal and abdominal series. Here, as is true in the United States, most of the hysterectomies were performed upon patients between the ages of forty and forty-nine.

The marital status of these patients shown in Table II requires little comment, other than to explain that Roman Catholic nuns have invariably been operated upon by laparotomy in this clinic even though they could have been operated upon through the vaginal route.

It has long been maintained that it is technically more difficult (it has also been considered a contraindication) to perform a vaginal hysterectomy upon a nulligravida than upon a multipara. This is not altogether true, for in the latter as a result of chronic parametritis the operation may be even more difficult due to difficulties in separating the bladder from the cervix, ligating a shortened hard Mackenrodt's ligament and bringing down the uterus. Also women past the menopause may have a vagina so shrunken that the cervix and uterus appear inaccessible. However, an episiotomy in nulligravida and an incision in the lateral vaginal wall in climacteric women will facilitate the necessary approach.

The question of anesthesia is largely one of individual preference. However, spinal anesthesia effects prolonged deep muscular relaxation desirable when performing a panhysterectomy via laparatomy. Because the hysterectomies in the abdominal series were nearly all difficult to perform due to the presence of extensive adhesions and large tumors, spinal anesthesia was employed in 82 per cent of the patients. On the other hand, vaginal hysterectomies are shorter in duration and do not require such deep muscular relaxation. Therefore, intravenous anesthesia was employed in 81 per cent of the series. There were no anesthesia accidents.

In simple vaginal hysterectomies, i.e., those without removal of adnexa and without adhesions, the peritoneal cavity was closed so that the gauze drain was in the vagina only. When adhesions were encountered and adnexa were removed, the peritoneal cavity was left open. In these cases the gauze drain was introduced to just

within the peritoneal cavity. In abdominal hysterectomies, wherever possible, the peritoneal cavity was closed so that only the subperitoneal space was drained. The

Table I
AGE DISTRIBUTION

Age in Years	Vaginal Hysterectomy	Abdominal Hysterectomy
20–29	1	0
30–39	9	11
40–49	56	57
50–59	29	23
60–69	4	5
70–	1	4

Mikulicz's tampon was employed to prevent infection of the peritoneal cavity in which large areas were left raw, rough and denuded of peritoneum following the removal of pus tubes. When absolute surgical

Table II
MARITAL STATUS

	Vaginal Hysterectomy	Abdominal Hysterectomy
Married	70	45
Single	10	18
Widow	13	15
Divorced	7	14
Sisters	0	8

control of bleeding and oozing surfaces was impossible, a Logothetopulos tampon was resorted to. One patient was tamponed from above and one from below.

Table VI compares the average number of days spent in the hospital. That average time in days for the abdominal series is greater than for the vaginal series may be accounted for by: (1) the former had more extensive pathology and therefore required more extensive surgery, (2) more than 10 per cent of that series required from ten to forty-five days of preoperative care before surgical intervention could be considered, (3) postoperative complications developed more frequently. In that series systemic complications played no part (Table VIII). Three patients in the abdominal series re-

Table III
PARITY

	Vaginal Hysterectomy	Abdominal Hysterectomy
Parity 0	22	49
Parity +	78	51

quired treatment for shock. In all, 18 per cent of the abnormal series could be described as having run an abnormal postoperative course as compared with 12 per cent for the vaginal series. It can be concluded that those patients from whom it is possible to remove the uterus vaginally can be assured of a smoother convalescence and

Table IV
ANESTHESIA

	Vaginal Hysterectomy	Abdominal Hysterectomy
General (open ether)	18	15
Intravenous (eunarcone)	81	3
Spinal	1	82

a shorter stay at the hospital than when it is removed abdominally, an important factor to remember when operating upon women who must return to their work as soon as possible.

Patients are less apprehensive of vaginal work than of abdominal work, and therefore more readily consent to indicated surgical intervention. There is a lower incidence of postoperative tympanites. Patients are more likely to void spontaneously, and in the presence of respiratory difficulties breathe and cough far more easily following a vaginal hysterectomy than an abdominal hysterectomy. These definite

advantages of the vaginal route over the abdominal route cannot be ignored.

Those patients (Table VIII) suffering from systemic disturbances in addition to their pelvic disorders, severe enough to make them poor surgical risks, were given indicated treatment before submitting them to surgery. In the vaginal series four patients were admitted with a past history of adnexitis, one with thrombophlebitis and one with parametritis. In the abdominal series fourteen patients were admitted with a past history of adnexitis, one with a parametritis and one with tubercular peritonitis. All these had been treated nonsurgically. In Table IX are noted the operations performed previous to admission upon the patients in both series.

TABLE V
DRAINAGE

	Vaginal Hysterectomy	Abdominal Hysterectomy
Vaginal	91	83
Logothetopulos	9	10
Mikuliczs	0	6
Logo. and Mik. combined	0	1

Most operators doing vaginal hysterectomies restrict their work to those patients free from adhesions and to those never previously operated upon. Generally speaking this may be wise, yet it is the experience of this clinic that even some of these (patients previously operated upon and those with adhesions), may be successfully operated upon vaginally. Occasionally, patients are seen whose general condition may be poor and their pelvic inflammation so severe that they cannot be influenced by conservative treatment. For these pelvic invalids the vaginal route is especially advantageous because following the vaginal hysterectomy there will be an absorption of exudates and a relief from symptoms, a most gratifying response to an operation one might reluctantly perform per laparotomy. One real contraindication to a vaginal hysterectomy based upon adhesions is the presence of a tumor large enough to reach the umbilicus so that the adhesions cannot be brought down to the vagina to be separated under direct vision. Only such severe cases, treated ineffectively for long periods, are eventually operated upon per laparotomy.

TABLE VI
HOSPITAL DAYS

Average No. of Days	Vaginal Hysterectomy	Abdominal Hysterectomy
Total hospital days	19.5	25.4
Preoperative days	2.6	5.6
Postoperative days	16.9	19.8
Days before ambulatory	10.5	11.1

The complaints (Table X) are similar to those of any larger series of hysterectomies and differ little from each other except that in the vaginal series the incidence of abnormal bleeding was greater and in the abdominal series the incidence of abdominal pain was greater. In a similar table prepared by Dupertius and Zollinger 72 per cent of the abdominal panhysterectomies complained of abnormal bleeding as compared to 25 per cent for the vaginal series. Just why this difference should exist is not known. Although a complete prolapse, especially in older patients, is in many clinics a good indication for a vaginal hysterectomy, only six in this series (none in the abdominal) had a complete prolapse. Evidently, fewer patients presented themselves with this complaint or other operative measures were instituted to control or relieve uterine prolapse.

Table XI reveals that 68 per cent of the vaginal series had a hysterectomy only, while in 70 per cent of the abdominal series both adnexa were removed. That the abdominal series had more pathology and required more extensive surgery does not entirely explain this difference. Today few men when performing a hysterectomy upon a woman near or at the menopause hesitate to remove both ovaries even though they

appear normal and healthy. However, because their removal, when operating from below, is not always technically easy and may prolong operating time, it is customary to leave them intact unless they are diseased. On the other hand, when operating from above their removal is so easy that they are usually sacrificed with the uterus.

Table VII
POSTOPERATIVE COMPLICATIONS

	Vaginal Hysterectomy	Abdominal Hysterectomy
Thrombophlebitis	5	6
Pulmonary embolism +	1	0
Bronchitis	1	1
Cystitis	10	12
Infection of abdominal wound	0	8
Rectovaginal fistula	0	1
Pleurisy	0	1
Septicemia +	0	1
Purulent peritonitis +	0	1
Pneumonia	0	2

Note: + = death.

In the vaginal series anterior colporrhaphy and colpoperineorrhaphy were done when indicated. To facilitate the operation the lateral vaginal wall was incised in five patients who had shrunken vaginas, morcellement in eighteen, enucleation in one, sagittal section of the uterus in eight and incision of the uterus and cervix in two. Because it was not customary to do a routine appendectomy with every laparotomy only two appendices were removed. There were three postoperative and two umbilical herniotomies incidental to the abdominal panhysterectomy.

In the vaginal series (Table XII) the right ureter was injured in one patient. This patient ran a perfectly normal postoperative course until the seventh day when moisture identified as urine escaped from the vagina. When this persisted, three weeks later a cystoscopic examination showed that no urine appeared from the right ureteral oriface. Two weeks later (six weeks postoperative), when spontaneous healing of the ureteral fistula could no longer be hoped for, an exploratory laparotomy was undertaken. The ureter was exposed to the point of entrance into the bladder without demonstrating evidence of trauma. When division of the ureter at its insertion into the bladder showed urine coming from it, it was decided to implant it into the bladder. That this was successful was demonstrated by the escape of urine from the new ureteral orifice during a cytoscopic examination made two weeks later. In the vaginal series the bladder during its separation from the cervix was slightly injured in one instance but not enough to require repair.

Table VIII
SYSTEMIC COMPLICATIONS

	Vaginal Hysterectomy	Abdominal Hysterectomy
Secondary anemia	2	1
Cardiac decompensation	1	1
Diabetis mellitus	1	2
Pulmonary tuberculosis	1	0

In the abdominal series the bladder was so slightly injured once as not to require repair and three times sufficiently injured to require repair. The rectum was injured in one and the sigmoid in another patient. All these injuries occurred during difficult dissections through dense adhesions and infiltrated areas. All were successfully repaired.

Immediate hemorrhage, that is surface bleeding and oozing at the conclusion of the operation from large wounds or areas denuded of peritoneum whose effective surgical control was either impossible or too time consuming, was controlled with a Logothetopulos tampon. This occurred four times in the vaginal series, seven in the abdominal. Delayed active bleeding (eighth day) suddenly developed from the right parametrium in one of the vaginal hysterectomies which was readily controlled with simple tamponage.

There was no morbidity in 59 per cent of the vaginal series while 41 per cent required

an average of 5.8 days to become afebrile (30 Celsus). In the abdominal series there was no morbidity in 68 per cent while 32 per cent required 5.9 days to become afebrile. There is, therefore, little difference in the temperature reaction between the two series.

TABLE IX
PREVIOUS OPERATION

Vaginal Series		Abdominal Series	
Vag. diagnostic currettage	11	Lap. appendectomy	4
Vag. induced abortion	6	Lap. enucleation of fibroid	1
Vag. vaginal tumor?	2	Lap. stomach	1
Vag. removal of cervical polyp	3	Lap. sterilization	1
Vag. biopsy of cervix	1	Lap. Doleris-Gilliam	1
Removal of renal calculi	1	Lap. drainage of abscess	1
Vag. anterior colporrhaphy	1	Lap. cesarean	1
Vag. colpoperineorrhaphy	1	Lap. ectopic pregnancy	1
Vag. interposition	1	Lap. ovarian cyst	1
Vag. vesicofixation	2	Vag. induced abortions	1
Lap. adnexal tumor	2	Lap. adnexal tumor	5
Lap. cholecystectomy	1	Lap. cholecystectomy	1
		Vag. diagnostic currettage	1

An indwelling catheter was employed in nine patients of the vaginal series and in eleven of the abdominal series. Irradiation therapy was given routinely to those in whom a diagnosis of malignancy of either uterus, cervix or ovaries was established. Therefore, eight in the vaginal series and fourteen in the abdominal series were so treated. Two patients in the vaginal series had received *x*-ray therapy preoperatively in a vain attempt to control functional bleeding of the menopause.

To list all the pathological findings from 200 hysterectomies would be impractical. Therefore, in Table XIII, were enumerated only the chief pathological findings and especially those that appeared to provoke the signs and symptoms indicating a hysterectomy. In common with all other surveys of hysterectomies fibroids occurred most frequently; next, internal adenomyosis for the vaginal series and diseases of the adnexa for the abdominal series. The high incidence of internal adenomyosis is striking especially when it is so rarely listed or even mentioned in similar studies made in the States; yet this diagnosis cannot be questioned, for it was in each instance made by an able pathologist, Dr. Priesel fo the Rudolfspital. This finding, however, helps to account for the high incidence of abnormal bleeding complained of by those in the vaginal series. The ectopic pregnancy was an accidental finding during the abdominal hysterectomy. The carcinoma of the cervix in the abdominal series was not diagnozed preoperatively, otherwise either a Wertheim or Schauta operation would have been performed. The carcinoma of the vaginal series was not diagnosed preoperatively, for the vaginal route is not knowingly employed for malignancy of the adnexa.

TABLE X
SYMPTOMS

Vaginal Series		Abdominal Series	
Abnormal bleeding	87	Abnormal bleeding	52
Back pain	21	Back pain	20
Abdominal pain	30	Abdominal pain	57
Urinary disturbances	3	Urinary disturbances	6
Leucorrhea	8	Leucorrhea	15
Loss of weight	6	Loss of weight	7
No symptoms	1	No symptoms	3
		Pruritus vulvae	1
		Sensation of foreign body in vagina	1
		Nausea	6

TABLE XI
OPERATIONS PERFORMED

	Vaginal Series	Abdominal Series
Hysterectomy	68	9
H. + bilateral adnexa	20	70
H. + right adnexa	5	7
H. + left adnexa	1	9
H. + right oöphorectomy	1	1
H. + left oöphorectomy	1	1
H. + bilateral salpingectomy	1	1
H. + left adnexa + right salpingectomy	1	1
H. + right adnexa + left salpingectomy	2	0
H. + bilateral oöphorectomy	0	1

Follow-up examinations (Table XIV) were made postoperatively at from two to twenty-four months. In the vaginal series eighty-three were asymptomatic at once while eleven required further treatment such as cauterization of granulation tissue or erosion of scar, diathermy treatments, sitz-baths and hot air baths before they became symptom free. Five patients due to anemia, persistent bladder symptoms, sensation of pain in the lower abdomen or to

a sensitive vaginal scar were classified as improved only. In the abdominal series eighty-seven were asymptomatic at once, seven required sitz-baths, diathermy treatments and injection of folliculin before they became symptom free. One patient had a postoperative hernia and three failed to report as instructed.

Table xii
operative complications

	Vaginal Series	Abdominal Series
Injury to ureter	1	0
Injury to bladder	1	4
Injury to sigmoid	0	1
Injury to rectum	0	1
Immediate hemorrhage	4	7
Delayed hemorrhage	1	0

Pulmonary embolism accounted for one death in the vaginal series. This patient ran a perfectly normal postoperative course until the nineth day when without warning she suddenly collapsed and expired within four hours. In the abdominal series there were two deaths. One, on the fifth postoperative day following a panhysterectomy for a large fibroid, started with lobar pneumonia, developed otitis media, acute nephritis and sepsis and expired on the fourteenth postoperative day. The other was an exceedingly poor surgical risk that had been treated conservatively for six weeks preoperatively for pelvic inflammatory disease. Following the difficult removal of the uterus and pus tubes through a mass of adhesions her condition became critical almost at once and, despite supportive treatment, she expired on the seventh postoperative day with a diagnosis of diffuse purulent peritonitis. (All three diagnoses were verified at autopsy.) The first two can really be classified as unpreventable accidental deaths. The third patient was operated upon only as a last resort after nonsurgical treatment had proved ineffective.

A comparison of this mortality rate with that presented by several others is listed in Table xv. The low mortality rate reported for this clinic may be explained in two ways, (1) other authors have compiled their statistics from the records of several operators with varied technics while this one has been compiled from the records of but one operator; (2) others occasionally perform a panhysterectomy for carcinoma of the cervix or include Wertheims in their statistics, while in this clinic the Wertheim is performed only for carcinoma of the cervix and these were not included in the survey.

Table xiii
pathological findings

Vaginal Series		Abdominal Series	
Fibroids	43	Fibroids	41
Internal endometriosis	38	Internal endometriosis	14
External endometriosis	2	External endometriosis	4
Salpingitis	14	Salpingitis	29
Cystic ovary	7	Cystic ovary	22
Carcinoma of ovary	1	Carcinoma of ovary	6
Chronic cervicitis	5	Chronic cervicitis	1
Hyperplasia	15	Hyperplasia	6
Carcinoma of fundus	5	Carcinoma of fundus	4
Hydatidiform mole	1	Sarcoma of fundus	3
Uterine polyp	1	Oöphoritis	8
Adenoma destruens	1	Carcinoma of cervix	1
Chronic metritis	1	Ectopic pregnancy	1
		Teratoma	1
		Brenner's tumor of ovary	1

COMMENT

It is hoped that this analysis of vaginal hysterectomies (gathered over a period of two years), and of abdominal panhysterectomies (gathered over a period of four years), none of which have been previously reported will prove to be an acceptable contribution to the literature. That the vaginal route for panhysterectomy should be employed whenever possible has long been maintained by such men as Babcock, Tyrone, Heaney, Kennedy and many others. Chavannaz of France, modern pioneer of vaginal hysterectomy, performs only about 5 per cent of all his panhysterectomies per vaginam while Werner performs about 66 per cent of all his panhysterectomies by that route.

While carcinoma of the cervix or the adnexa, the presence of dense adhesions and a tumor extending up to the umbilicus

and chronic appendicitis remain real contraindications to employing the vaginal route, the marked advantages of this route cannot lightly be ignored. A better appreciation of the shorter operating time, shorter hospitalization, lower mortality and morbidity rates, smoother convalescence, fewer operative and postoperative complications and excellent end results achieved would we believe, if generally appreciated, eventually persuade surgeons to elect the vaginal route in preference to the abdominal wherever possible.

TABLE XIV
FOLLOW-UP STUDIES

	Vaginal Series	Abdominal Series
Asymptomatic at once	83	87
Asymptomatic finally	11	7
Improved only	5	1
Failed to report	0	3

TABLE XV
MORTALITY RATE

	Vaginal Series	Abdominal Series
Witherspoon and Butler	2.7	5.3
Faulkner	2.9	2.6
Dupertius and Zollinger	0.0	4.0
Werner	1.0	2.0

TECHNIC

The essential features of a simple vaginal hysterectomy according to Dr. Werner's technic are as follows: circumcision of the cervix at the junction between the smooth part of the mucous membrane immovably adherent to the cervix underneath and the wrinkled movable part; advancing the bladder off the cervix and opening the anterior cul-de-sac: opening the posterior cul-de-sac; tying off the parametria; rolling the fundus forward into the vagina; separation of the uterus from the adnexa; fixation of the peritoneum and the stumps of the adnexa and parametria to the edge of the vaginal mucosa; and tying together of these last placed lateral sutures, thus closing the cavity. When the adnexa are removed, this last step is unnecessary for a prolapse of the bowel never occurs.

The abdominal panhysterectomy differs but little from the technics commonly employed, although emphasis is placed upon the exact control of hemorrhage by dissecting free all ligaments before opening the vagina and the placing of clamps to both sides of the vagina with adjacent connective tissue. Failure to place these clamps invites oozing from one or both sides of the vaginal walls which can be controlled with difficulty only by placing many ligatures in a field rendered dangerous by the close proximity of the ureter.

The Logothetopulos tampon differs from the Mikulicz's tampon in that ends of it projecting from the vulva are twisted and under tension fixed to a pessary ring in front of the vulva. This tension is maintained for about six hours. Both the Logothetopulos and the Mikulicz's tampons are removed gradually, a portion of it being withdrawn day by day until it is finally removed upon the sixth or seventh days. While the tampon is in situ, it is wise to place an indwelling catheter because these patients are rarely able to void spontaneously.

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MECKEL'S DIVERTICULUM*

REPORT OF TWO CASES

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ONCE considered an anatomical curiosity, Meckel's diverticulum is now recognized as a definite pathological entity, as the result of numerous case reports and related publications appearing in recent years.

HISTORY

Lavater,[1] in 1671, reported his observations on an instance of diverticulum of the terminal ileum. This is one of the first recorded cases. In 1707, Ruysch[2] gave an excellent illustration of such a diverticulum in his Thesaurus Anatomicus. Morgagni,[3] in 1769, discussed diverticula of the intestine. He did not believe, however, that diverticula of the ileum had any relation to the omphalomesenteric duct.

It was Johann Friedrich Meckel (1781–1833) to whom the credit is given for the first association of the diverticulum of the terminal ileum with the omphalomesenteric duct. Livingston[4] has pointed out that considerable confusion has arisen regarding the credit because of the fact that two anatomists, grandfather and grandson, had identical names. Credit is given by many writers to the elder Meckel (1717–1774). However, the writings of this anatomist fail to show that he studied or described the diverticulum in question. The elder Meckel described the sphenopalatine ganglion and the space enclosing the Gasserian ganglion (Meckel's ganglion and Meckel's Cavity), but it was the grandson who studied and wrote extensively concerning the omphalomesenteric duct and described the diverticulum occasionally found as a remnant of this fetal structure. In 1809, he compiled a collection of all cases recorded to that date. He also pointed out the association of the diverticulum with other congenital anomalies, such as hare lip, cleft palate and bicornate uterus.

EMBRYOLOGY

Ordinarily the proximal end of the yolk stalk becomes obliterated early in fetal life, usually beginning about the fifth week. When it remains as a sac or pouch of varying lengths and attachments, it is known as Meckel's diverticulum. The yolk sac at first is filled with the vitelline fluid, which probably is utilized for nourishment of the embryo in the early stages of its existence. It later has an important function in the formation of blood, the first blood cells and vessels developing in the outer mesodermal layer. At the end of the fourth week the yolk sac appears as a pear-shaped vesicle (the umbilical vesicle), opening into the intestine by a long narrow tube, the omphalomesenteric (vitelline) duct. As stated above, obliteration starts at about the fifth week of fetal life and is completed at about the seventh week. In rare cases there may be no closure, and a fistulous opening from the intestine through the umbilicus results. In some instances there is an obliteration except for the distal portion and as a consequence there is an umbilical fistula with secretion from the still active glandular elements in the mucosa. In other rare instances, the proximal and distal portions close but an opening may remain in the middle portion. Due to secretory activity a retention cyst is formed, the so-called enterocystoma. The usual type, however, is a diverticulum of varying size and length originating from

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the terminal ileum, the distal end either lying free in the peritoneal cavity or connected by a fibrous band to the umbilical

FIG. 1. Case 1. The diverticulum as seen at operation.

region. Very rarely, there may even be a duplication of the diverticulum. Carlson[5] recently reported a case in which there were two diverticula about 20 cm. apart in the ileum. The anomaly was found in a thirty-eight week old male fetus. Elements of the gastrointestinal tract other than mucosa of the small intestine are found at times in the diverticulum. Such elements may include gastric and duodenal mucosa, and aberrant pancreatic tissue. Greenblatt[6] and his co-authors estimate that 15 to 25 per cent of the diverticula show the presence of heterotopic tissue.

INCIDENCE

The diverticulum is found in about 2 per cent of autopsies. In 2,050 postmortem examinations at the New York Hospital, the diverticulum was present in thirteen cases. Christie[1] recently presented a pathologic study of sixty-three cases found in 5,768 autopsies at Babies Hospital, an incidence of 1.1 per cent. Gray's Anatomy[7] gives an incidence of 2 per cent; Richardson,[8] 1.5 per cent.

SEX DISTRIBUTION

The proportion of males to females is estimated as 3:1. Ketteler[9] in reporting 109 cases of Meckel's diverticulum found only eighteen cases in females as compared with ninety-one in males. No satisfactory explanation has ever been offered for this difference in the sex incidence.

LOCATION AND SIZE

The usual location of the diverticulum is approximately 100 cm. from the ileocecal valve and opposite the mesenteric attachment of the gut. It may be found anywhere in the gastrointestinal tract from the cardia to the rectum in rare cases, according to the statement of Nygaard and Walters.[10] Hadley and Cogswell[11] recently reported a diverticulum which had its origin from the base of the appendix. In a search of the literature prior to their report, they were unable to find any reference to a diverticulum nearer than 4 cm. to the ileocecal valve. Cunningham's Anatomy[12] states that, in a large series of autopsies, the greatest distance from the valve was 12 feet and the least was 6 inches. In a series of sixty-three cases reported by Christie the diverticulum nearest to the ileocecal valve was 15 cm. and the most distant was 90 cm. The usual location is opposite the mesenteric attachment but this may not always be the case. Thompson[13] reported a case of perforated peptic ulcer in a Meckel's diverticulum, the diverticulum being intramesenteric in position. There may or may not be a separate mesentery. In size it may vary from a barely perceptible outpouching of the intestinal wall to the huge diverticulum reported by Moll[14] which measured 33½ inches (85.09 cm.) in length. Goldstein and Cragg[15] recently reported a diverticulum measuring 66 cm. in length which was removed from a five year old girl at operation. An unusual feature of this diverticulum was that it shared a single mesentery with the ileum. Occasionally the diverticulum may be bifurcated. Hyrtl[16] presented a patient in which it was not only bifurcated

but serrated into five distinct parts. The average diverticulum is, however, approximately the size and length of a finger.

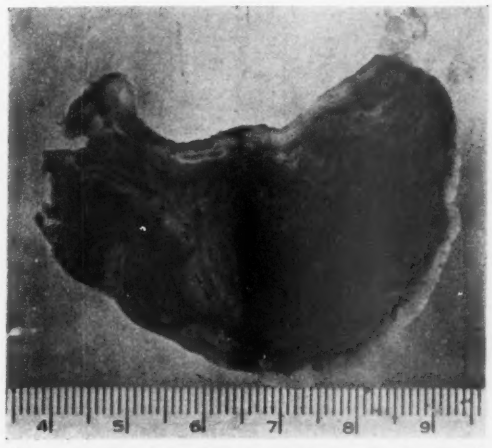

Fig. 2. Case I. Cross section of the fixed specimen showing the almost complete obstruction of the lumen by triangular cone.

COMPLICATIONS

The majority of persons having this anomaly undoubtedly go through life entirely symptom-free. It has been estimated that approximately one-fourth of all cases will eventually show some pathologic change.

a. Hemorrhage. Gastric mucosa frequently is found in the diverticulum. Farr and Penke[17] found such mucosa in six of thirteen diverticula while Hudson and Koplik[18] also found about the same proportion, twelve cases out of a total of twenty-three showing gastric mucosa. Ulceration with hemorrhage is probably the most common complication. In thirty-two cases reported by Hudson and Koplik,[18] seventeen showed hemorrhage either with or without other signs. Bleeding from the rectum is therefore an extremely important diagnostic sign, especially in the acute surgical diseases of the abdomen.

b. Perforation. Perforation into the peritoneal cavity is the next most common complication. The first authentic report of a definite peptic ulcer within a Meckel's diverticulum was made in 1913 by Hubschmann.[19] He operated on a four and a half year old boy for an "acute abdomen" and found a perforated peptic ulcer in this organ. Examination of the specimen showed a typical perforated peptic ulcer with

Fig. 3. Case II. *X*-ray picture showing the isolated collection of barium in the region of the umbilicus.

gastric mucosa lining nearly all of the diverticulum.

c. Diverticulitis. The diverticulum may also be the site of a purely inflammatory process, the so-called diverticulitis. The inflammation may be acute catarrhal in character or the more serious suppurative and gangrenous forms with accompanying abscess formation and peritonitis. The symptoms of an acute diverticulitis differ in no way from a similar inflammatory change in the appendix. A differential diagnosis is usually impossible. The treatment, fortunately, is the same in both instances, i.e., surgical intervention.

d. Obstruction. Intestinal obstruction is another complication of a Meckel's diverticulum. In a diverticulum extending to and adherent in the umbilical region, a loop of bowel may drop across the diverticulum causing obstruction as in Case I below. In inflammation of the diverticulum the inflamed portion may become adherent

to adjacent intestine, producing obstruction by compression and constriction. Intussusception not infrequently occurs if

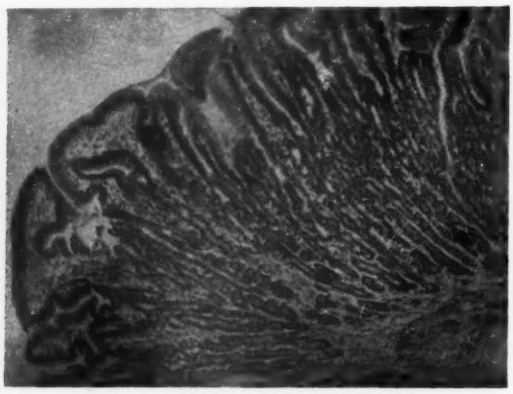

Fig. 4. Case II. Microphotograph showing the glandular structure of the diverticulum similar to that of the gastric fundus.

the diverticulum should become invaginated, in which case it acts as a polyp within the lumen of the bowel. Volvulus is an occasional finding.

e. New Growths. Rarely the diverticulum may be the site of new growths, either benign or malignant. Nygaard and Walters in a survey made in 1937 found a total of twenty cases of malignant tumors of Meckel's diverticulum. Fourteen cases were of sarcoma and six of carcinoma. Of benign tumors, myoma and lipoma of the diverticulum have been reported.

f. Miscellaneous. Very rarely, the diverticulum may be the site of a tuberculous or typhoid ulceration. In the latter, the ulceration requires the presence of Peyers' patches.

Case I. This was an obstruction of the bowel associated with torsion and gangrene of a Meckel's diverticulum. A young male, aged 25 years, American born, a coal loader, had been in good health up to the onset of the illness, except for a mild constipation. About 4 A.M. on May 18, 1938, he was awakened by severe intermittent cramping pain, localized in the region of the umbilicus. At about the same time he felt a desire to defecate and, as he could not walk due to the pain, he dragged himself to the toilet where he had a very loose stool. This relieved the pain and he was comfortable for one hour. Following this, the cramping pain again returned, fully as severe as before, causing him to writhe in bed. He was nauseated and vomited once about 6 A.M., the vomitus being watery and green in color. The nausea persisted but there was no further vomiting. His family physician first saw the patient about 9 A.M. By this time the pain had changed from a severe intermittent cramping to a continuous dull ache localized just below the umbilicus. Hospitalization was advised but the patient refused until four hours later when the persisting pain finally caused him to make the trip. He was admitted to the hospital at 2 P.M. approximately ten hours after the onset of illness. The past history was important in that four years previously he had had an attack of severe cramping pain similar to the present illness. That attack lasted only about fifteen minutes and had been relieved by a small dose of paregoric. His only previous hospitalization had been in 1933 for the surgical correction of a ventral hernia directly above the umbilicus. He had had the usual childhood diseases. He had been in excellent health prior to the onset of the present illness; on the previous evening he had practised baseball with a local team. He had taken no cathartics prior to his illness.

Examination revealed that the patient was a well developed and well nourished, stocky, white adult male, obviously acutely ill, and complaining of continuous aching pain just below the umbilicus. The pulse rate was 96; the blood pressure 158 systolic and 104 diastolic; the temperature 100°F. by mouth. His respirations were 20 per minute and predominately thoracic in type. Examination of the mouth and throat showed an extremely high, hard palate but there was no evidence of congenital stigmata otherwise. The teeth showed numerous extractions and moderate caries. The heart and lungs were entirely normal to physical examination. Inspection of the abdomen showed a healed surgical scar 2½ inches in length, directly above the umbilicus. There was moderate distention, especially in the upper abdomen. There was tenderness to palpation over the lower abdomen, a little more marked on the right side than on the left. On deep palpation a mass could be made out lying about 1 inch below and to the right of the umbilicus. The mass was deeply situated, its size and position could not be definitely determined. Rebound tenderness was marked. The abdominal wall moved only slightly with respiration. No peristaltic waves were noted. A fluid wave,

areas of shifting dullness and obliteration of liver dullness were absent. The rectum was empty and no mass could be felt in the lumen above or impinging on the rectal wall. There was tenderness to pressure high up and on both sides of the rectum. The erythrocyte count was 4,000,000, and the leucocyte count 16,000 with 95 per cent polymorphonuclears. Urinalysis was unchanged.

Because of the severity of the abdominal symptoms, coupled with the palpable mass, fever, and leucocytosis, immediate operation was advised. A preoperative diagnosis was made of intestinal obstruction, cause unknown.

Under spinal anesthesia (neocaine, 150 mg. introduced into the third lumbar interspace) with ether analgesia in the latter stage, the peritoneal cavity was entered through a right rectus incision. A moderate amount of cloudy, odorless, brownish fluid was encountered and was removed by aspiration from the peritoneal cavity. The intestines were moderately distended and showed slight hyperemia. Lying in the lower portion of the right hypochondrium, just anterior to the gallbladder, was a dark, gangrenous object, about the size of an ordinary sausage. At the proximal end, the mass was found to communicate with the small intestine along the antimesenteric border and apparently in the region of the terminal ileum. The distal end was traced to the umbilicus, establishing the diagnosis of a strangulated Meckel's diverticulum. The diverticulum showed marked torsion, being twisted on itself through two complete turns at the intestinal and umbilical junctions. Lying across the strangulated diverticulum, in a manner similar to which clothes may be hung on a line, was found a loop of small intestine, measuring about 15 inches. This was kinked sharply at the point of crossing the diverticulum causing an obstruction of the small bowel. This loop of bowel was more distended than the remainder of the intestine and of a darker color due to circulatory stasis. The obstructed loop of gut was pulled up and returned to its normal location within the peritoneal cavity with a marked improvement in the color of the loop after this procedure. The abdominal cavity was then protected by gauze against soiling and the diverticulum brought up into the operative field. The base of the diverticulum was clamped, cut, carbolized and invaginated into the ileum using a black silk purse string suture. A few reinforcing seromuscular sutures were then placed at the site of the inversion. The caliber of the adjacent intestine was not appreciably diminished by this procedure. The distal, fibrous end of the diverticulum above the site of torsion was then clamped and cut, and a chromic No. 1 tie placed about the remaining short stump. The appendix was grossly normal and was removed in the usual manner prior to closure.

The patient had a smooth and uneventful recovery following the operative procedure. The highest elevation of temperature, 100.6°F. occurred thirty-six hours after operation. This became normal the following morning and remained so for the duration of the hospital stay. There was no nausea or vomiting and only a slight distension for forty-eight hours after operation. The sutures were removed on the eighth postoperative day. The wound remained clean and healed by primary intention. The patient was allowed out of bed on the tenth and was discharged on the fourteenth postoperative day. Since leaving the hospital the patient has been seen from time to time in the out-patient department, the last visit being almost a year after operation. There have been no complaints referable to the gastrointestinal tract. Recent examination showed him to be in excellent physical condition. The abdomen was soft, the scar firm and there were no areas of tenderness. The patient has resumed his regular occupation and activities; he is now playing semiprofessional base ball several times a week.

The pathologic report stated that the diverticulum measured 5.4 by 4.0 by 2.2 cm. (after fixation) and bore a striking resemblance in form to a stomach. Both the proximal and distal ends were about 0.5 cm. in diameter and showed several complete twists. The color was purplish black with little patches of fat being seen in the external wall. A longitudinal section was made connecting the edges of the lesser and greater curvatures. A valve-like triangular cone was found originating from the lesser curvature near the intestinal end. This cone projected into and partially obstructed the lumen of the diverticulum. Microscopic examination revealed the diverticulum to be so thoroughly necrotized as to make impossible any recognition and defination of glandular structures. The whole tissue was impregnated with blood. Large areas showed the segmented nuclei of polymorphonuclear leucocytes, and in

other regions pycnotic nuclei surrounded by undefinable cell débris were seen. Pancreatic tissue was not found.

Case II. This was an instance of bleeding Meckel's diverticulum in an eleven months old infant. A white, male infant, aged eleven months, was admitted to the hospital on July 5, 1939, because of bleeding from the bowels. The patient was a full term baby, spontaneous delivery. His first tooth erupted at six months, he was able to sit up at nine months, and the weight curve had been satisfactory since birth. There was no history of any illness since birth other than a mild, acute upper respiratory infection when six months of age, which cleared completely after about seventy-two hours. The onset of the present illness dated to three months prior to admission when the mother noticed a blood stained diaper. Thirteen days after the initial attack, the baby passed a large amount of blood from the bowels, enough to fill several diapers with clots. The baby appeared very pale and was taken to a hospital where a transfusion was given. For five days following this the stools were dark and blood stained. No cause or source of the bleeding was found at that time. The baby picked up very well and there was no further difficulty until just prior to admission when the mother noticed that the diapers were again blood stained with several large clots also present. The baby was then brought immediately to the hospital for further care.

When first seen at the hospital, the patient was a very well developed and well nourished, stocky, white male infant, lying quietly in bed, not appearing acutely ill. Examination of the head showed the anterior fontanelle to be widely open. The eyes, ears, nose and throat were normal except for a very high, hard palate. Six teeth had erupted. The heart and lungs were entirely normal. Examination of the abdomen revealed no abnormalities. The wall was soft and no masses were palpable. A few small lymph nodes were palpable in each inguinal region. The red cell count on admission was 4,100,000 and the white cell count 10,500 with 83 per cent hemoglobin.

The baby was placed under observation in the hospital and treated with small doses of paregoric and phenobarbital for sedation. On the day following admission, a gastrointestinal study was carried out. The opaque meal was followed through the small intestine and colon. Films taken in the lateral position showed a few flecks of barium near the umbilicus which might have indicated the position of a Meckel's diverticulum. At the end of six hours, however, an isolated collection of barium was found in the region of the umbilicus, the balance of the meal lying in the lower portion of the intestine, to the right of the midline. The roentgenologist noted that the margins of the isolated accumulation were less regular than the remainder of the intestine. He stated that this could very well be a Meckel's diverticulum filled with barium. The stools during this period of observation were dark in color but no gross blood was noted. The benzidine reaction, however, was 4 plus. Four days after admission, the baby again had two grossly bloody stools with several large clots, and on the following day there were three grossly bloody bowel movements. The red cell count showed a drop to 2,600,000 cells and the hemoglobin had been reduced to 50 per cent. The baby seemed to be more listless and pallor was increasing from day to day. It was believed that an exploratory laparotomy could no longer be delayed in view of the continued passage of blood and the rapid drop in the red blood cell count. A preoperative diagnosis of a bleeding Meckel's diverticulum was made and the patient prepared for surgery.

Under drop ether anesthesia, the peritoneal cavity was entered through a right rectus incision. The bowel loops were distended and tended to bulge up into the field. The cecum was identified and found to be filled with dark appearing material within the lumen. The appearance suggested the possibility of blood in the bowel. The ileum was then followed back, and approximately 18 inches from the ileocecal valve, a Meckel's diverticulum was found. The diverticulum had the appearance of a rimless derby hat lying on top of the bowel. It showed a very wide base and measured about ¾ inch in height. There was a moderate thickening to palpation when compared to the adjacent intestine, and several large vessels could be traced up from the bowel into the diverticulum. There was no mesentery. The diverticulum was brought up into the field and the adjacent intestine packed off to prevent soiling. A Dawson-Furniss crushing clamp was applied across the base and the diverticulum removed by cutting. The edges were carbolized and the clamp removed. Several bleeding vessels were

picked up and tied off with fine silk. Using the Connel stitch, the crushed edges were then inverted into the lumen with black silk. Three black silk supporting mattress sutures were then placed for reinforcement. At the close of the procedure, there was only a slight diminution in the caliber of the intestine, and on manipulation, gas could easily be passed through the slight constriction. The lumen appeared to be of sufficient size to permit the passage of an ordinary lead pencil. The appendix was grossly normal and was removed in the usual manner prior to closure. The abdominal cavity was not drained.

A transfusion of 175 cc. of blood into the brachial vein was given immediately after the operative procedure. The course during the first forty-eight hours following operation was very satisfactory. The feedings were well taken and there was very little abdominal distention. A formed stool which was covered with fresh blood was passed on the third postoperative day, followed several hours later by the passage of a second stool containing a large number of blood clots. Koagamin coagulant (Millar) was then administered intramuscularly in 3 cc. doses every three hours until a total of 12 cc. had been given. Two blood tinged stools were passed on the fourth postoperative day. The stools from that time on were free of gross blood, although the benzidine test remained positive for two more days. The patient was discharged on the eleventh postoperative day. The erythrocyte count was 3,100,000 and the hemoglobin 63 per cent at this time. The patient was seen recently in the out-patient department (January, 1940) and was found to be in excellent physical condition. A gastrointestinal study at this time was normal. The isolated collection of barium which had been found and identified as the diverticulum prior to operation was not seen at this time. There had been no further passage of blood in the stools.

The pathologic report was as follows: The diverticulum measured 2.5 cm. in height with a diameter of 2.75 cm. at the base. On the inner aspect, the mucosa was 1 mm. in thickness and thrown into numerous folds. The muscularis was 0.5 mm. in thickness. No ulcerations or bleeding points were seen. The microscopic examination revealed long tubular glands in the mucosa. Chief cells and many brightly stained parietal cells were seen. There were no focci of inflammation or areas of hemorrhage. A pathologic diagnosis was made of Meckel's diverticulum containing mucosa similar to that of the gastric fundus.

SUMMARY

1. A brief review is given of the history, embryology and incidence of Meckel's diverticulum.

2. The complications which may result from the presence of such a diverticulum are noted.

3. A case of bowel obstruction associated with torsion and gangrene of a Meckel's diverticulum is presented.

4. A case of bleeding Meckel's diverticulum in an eleven months old infant is presented.

CONCLUSIONS

1. The passage of blood by rectum, especially in children and in the presence of acute abdominal disease, should arouse suspicions of a Meckel's diverticulum.

2. Examination of the terminal ileum should, when possible, be routinely undertaken in abdominal operations.

3. In any abdominal surgery in which an adequate pathologic condition to explain the clinical findings is not found, a Meckel's diverticulum should always be ruled out.

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After middle life the sigmoid region of the gut becomes pouched in many places. These pouches are harmless unless they become inflamed.

COLOR ILLUSTRATIONS

COLOR illustrations, from time to time, have made their appearance in the pages of The American Journal of Surgery, and it has long been our ambition to offer more of these to our readers. Foreign scientific journals, because of lower labor costs, have been generous in publishing color illustrations. Often this has been made possible because of endowments for this purpose, as in the case of the *British Journal of Surgery*. In this country color illustrations, particularly when four colors are used, are very expensive. One such picture often runs into several hundred dollars, thus making the cost to both author and publisher prohibitive.

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T. S. W.

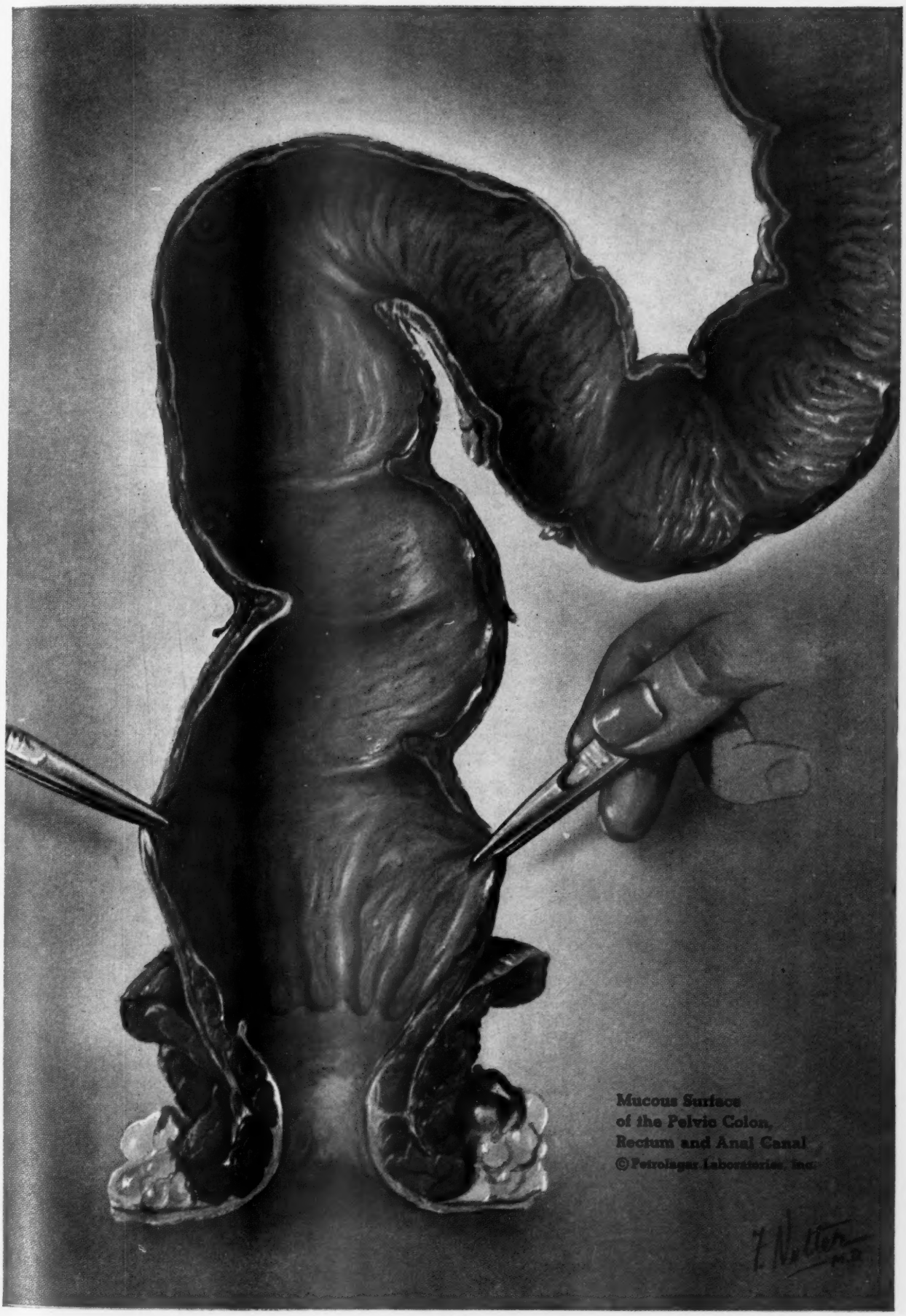
LOWER BOWEL, RECTUM AND ANAL CANAL

Mucous Surface of the Pelvic Colon, Rectum and Anal Canal

The Veins of the Descending and Sigmoid Colons, Rectum and Anal Canal

The Arterial Supply of the Sigmoid Colon, Rectum and Anal Canal

Musculature of the Lower Bowel



Mucous Surface
of the Pelvic Colon,
Rectum and Anal Canal
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MUCOUS SURFACE OF THE PELVIC COLON, RECTUM AND ANAL CANAL

THE mucous membrane of the lower end of the bowel is a thick, vascular layer. The surface of the sigmoid colon is usually considerably more rugous than that of the rectum. On sigmoidoscopic examination a rather sharp demarcation can often be seen between these two surfaces and this transition is demonstrated in the illustration. Scattered throughout the mucous membranes are numerous solitary lymphatic nodules.

Within the rectum there are three shelf-like projections, known as the "Valves of Houston." The uppermost and lowermost of these arise from the left side and the middle one from the right side of the bowel. At the lower end of the rectum the mucosa is gathered into longitudinal folds, approximately ten in number, known as the "Rectal Columns" or "Columns of Morgagni." These columns are united at their lower extremities by transverse semilunar mucosal folds to which the term "Anal Valves" has been applied. Each anal valve thus forms one wall of a pocket or saccule which is bounded externally by the rectal wall and on each side by a rectal column. These pockets are called "Crypts of Morgagni," or "Saccules of Horner." They are quite important clinically as they form a common point of entrance for infective organisms. Shortly below this point there is a transition from the intestinal mucosa to the anal skin.

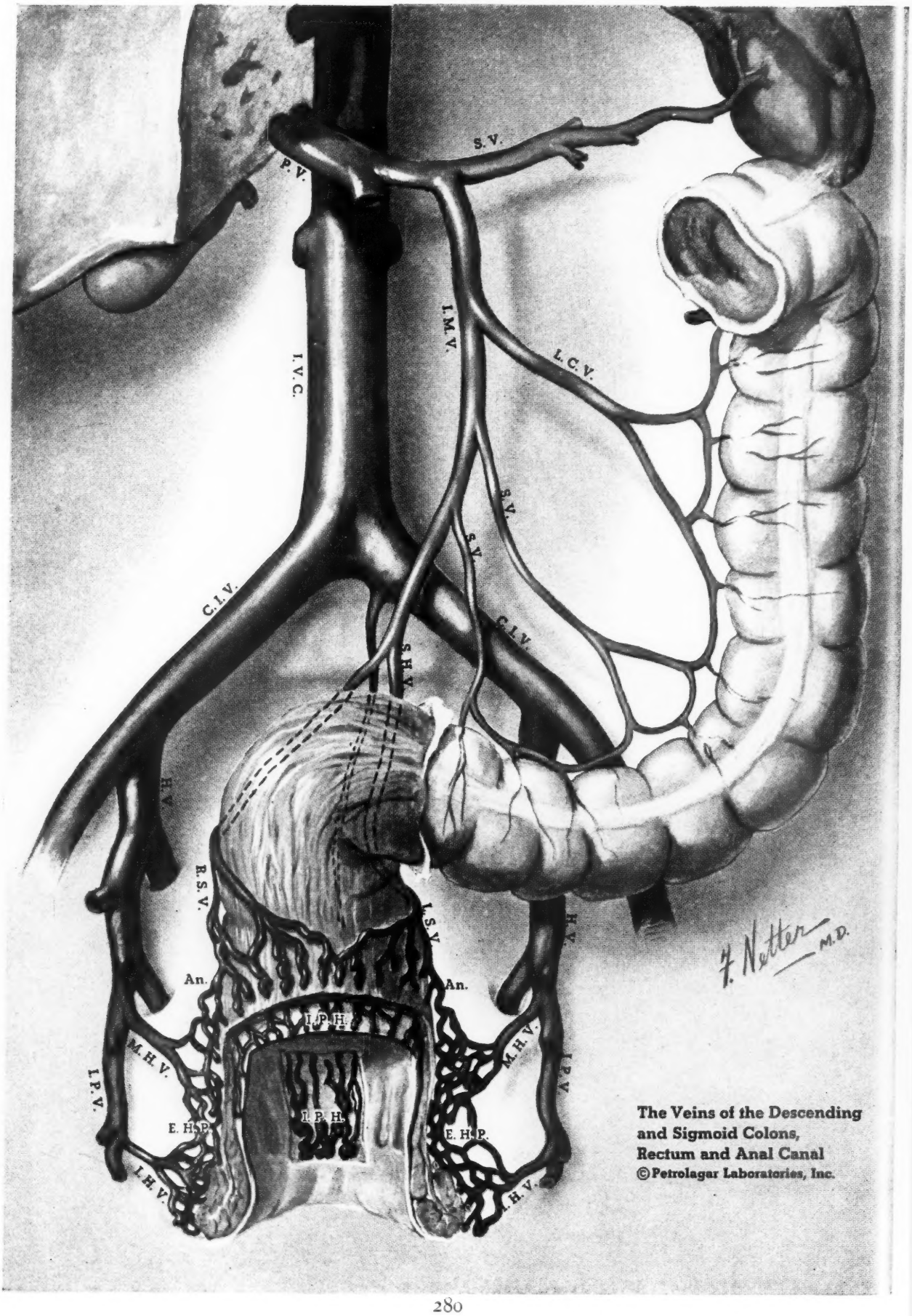
THE VEINS OF THE DESCENDING AND SIGMOID COLONS, RECTUM AND ANAL CANAL

THE venous system of the lower rectum comprises two plexuses, the internal or superior hemorrhoidal plexus (I.H.P.), and the external or inferior hemorrhoidal plexus, (E.H.P.). The internal or superior hemorrhoidal plexus consists of a network of small veins situated in the submucosa above the anorectal line. In the illustrations, a panel of mucosa has been removed from the posterior rectal wall to show this network. On the anterior wall, the muscular layer has been cut away at a higher level than has the mucosa in order to demonstrate the manner in which the small veins of this plexus course upward. At about the middle of the rectum, the veins penetrate the muscular layer. They continue upward on the outer surface of this muscular layer, uniting with one another to form the right and left branches of the Superior Hemorrhoidal Vein (R.S.V.) (L.S.V.). These branches course upward on the posterior aspect of the rectum and unite to form the Superior Hemorrhoidal Vein proper (S.H.V.). This in turn drains by way of the Inferior Mesenteric Vein (I.M.V.) and Splenic Vein (S.V.) to the Portal Vein (P.V.) and thus to the liver.

The External or Inferior Hemorrhoidal plexus is located *outside* the muscular layer of the lower rectum and anal canal. It is drained on each side by two veins, the Middle Hemorrhoidal, (M.H.V.) and the Inferior Hemorrhoidal (I.H.V.). The Inferior Hemorrhoidal vein is a tributary of the Internal Pudendal Vein (I.P.V.) which in turn enters the respective Hypogastric Vein (H.V.). The Superior Hemorrhoidal Vein drains directly into the Hypogastric. The Hypogastric Vein on each side joins the External Iliac to form the Common Iliac Vein (C.I.V.) and the two common Iliacs unite with each other to form the Inferior Vena Cava (I.V.C.) leading to the heart.

It is thus obvious that the Internal or Superior Hemorrhoidal plexus drains by way of the "Portal Circulation" while the External or Inferior plexus drains by way of the "Caval Circulation." The two plexuses, however, anastomose with each other (An.) and this anastomosis is of considerable significance as it forms a juncture point of the two great venous systems—the caval and the portal.

The blood from the Sigmoid Colon and Descending Colon is drained by way of the Sigmoid Veins (S.V.) and the Left Colic Vein (L.C.V.) into the portal circulation.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The Veins of the Descending and Sigmoid Colons, Rectum and Anal Canal
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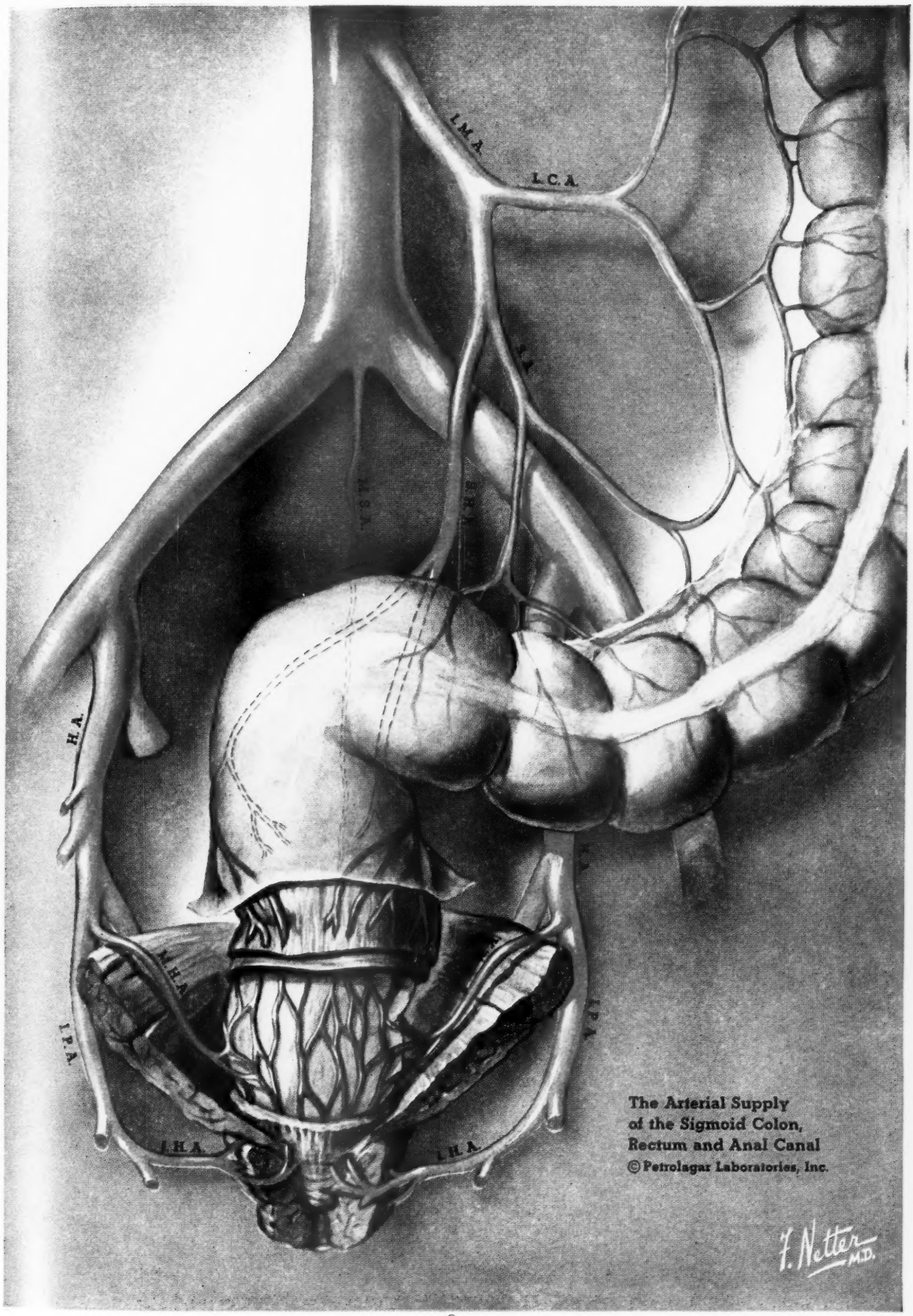
L.M.A.
L.C.A.
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The Arterial Supply
of the Sigmoid Colon,
Rectum and Anal Canal
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THE ARTERIAL SUPPLY OF THE SIGMOID COLON, RECTUM AND ANAL CANAL

THE Inferior Mesenteric Artery (I.M.A.), by means of its three branches, the Left Colic Artery (L.C.A.), the Sigmoid Artery (S.A.) and the Superior Hemorrhoidal Artery (S.H.A.), provides the blood supply for the descending colon, the sigmoid and the upper part of the rectum. The Left Colic Artery, in its rout to the colon, divides into branches which unite with each other to form a series of arcades. From these arcades branches are given off to the bowel. The uppermost branch of the artery anastomoses with the descending branch of the middle colic artery, while the lowermost anastomoses with a branch from the sigmoid artery. The Sigmoid Artery and the Superior Hemorrhoidal are the two terminal branches of the Inferior Mesenteric Artery.

The Sigmoid Artery courses downward in the Sigmoid mesentery and divides into branches which supply the Sigmoid Colon. The Superior Hemorrhoidal Artery crosses the left common iliac vessels and enters the pelvis to reach the posterior surface of the upper end of the rectum. Here it divides into a right and left branch which continue downward, winding around the rectum and subdividing further. At about the level of the peritoneal reflection, these branches pierce the muscular coats and form a plexus in the submucosa. This plexus also receives branches from the Middle and Inferior Hemorrhoidal Arteries (M.H.A.) (I.H.A.).

There are two Middle and two Inferior Hemorrhoidal Arteries (right and left). They arise from the anterior divisions of the respective Hypogastric Arteries (H.A.) and course medially over the pelvic floor to the sides of the rectum where they pierce the muscular layers and anastomose with branches from the Superior and Inferior Hemorrhoidals to form the submucous plexus. The Inferior Hemorrhoidal Artery on each side arises from the Internal Pudendal Artery (I.P.A.), a branch of the Hypogastric (H.A.), after that vessel has left the pelvis, i.e., in the Ischiorectal Fossa. It courses medially toward the anus, where it breaks up into branches that take part in formation of the submucous plexus. The Middle Sacral Artery (M.S.A.) also supplies a few branches to the posterior aspect of the rectus.

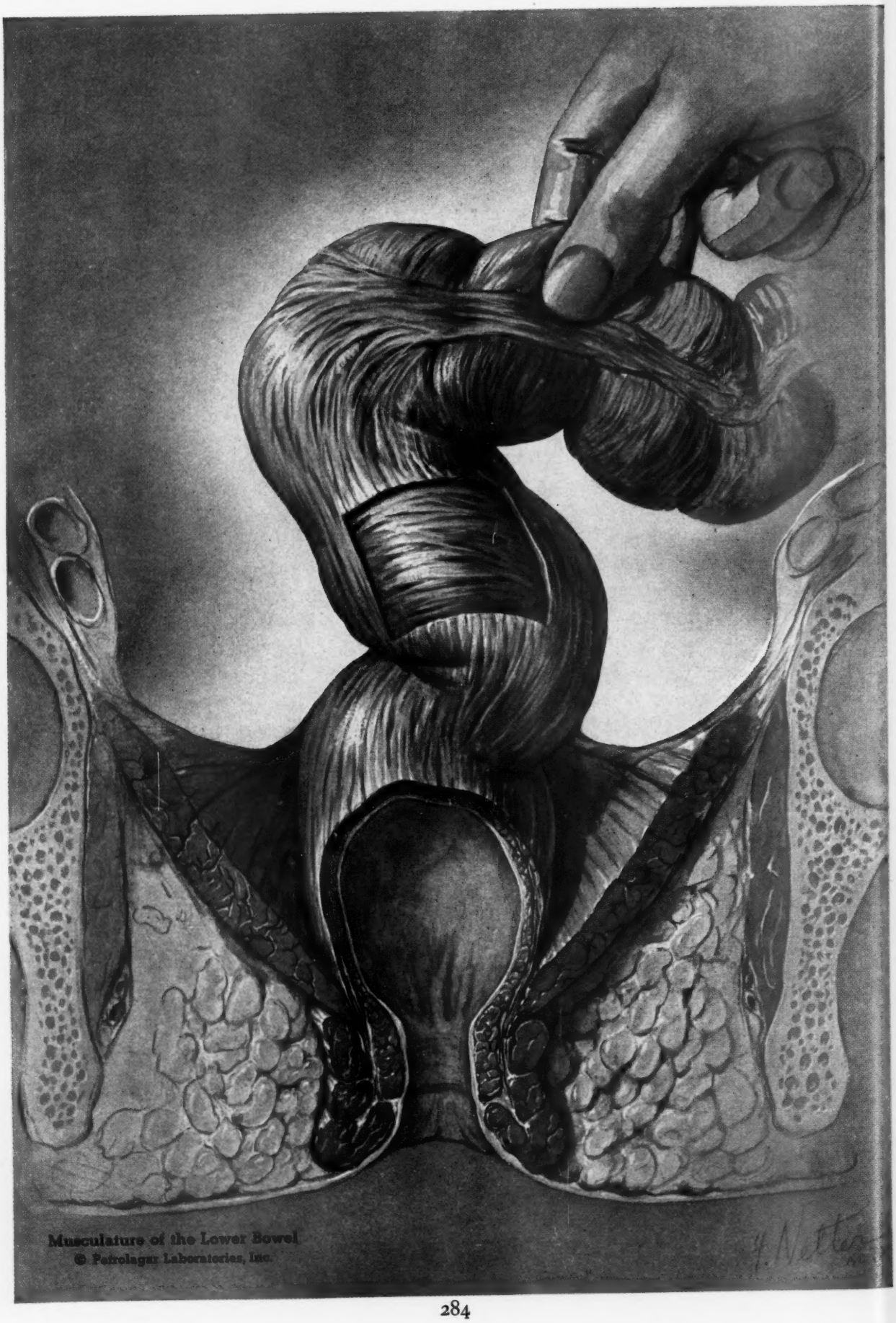
MUSCULATURE OF THE LOWER BOWEL

THE musculature of the large intestine is comprised of a circular layer and longitudinal layer. In the cecum, ascending colon, transverse colon, descending colon and sigmoid colon, the longitudinal layer is collected into three longitudinal bands—only one of these bands (the taenia libera) is visible anteriorly. At the juncture of the sigmoid colon with the rectum, the bands broaden out and fuse so as to form a complete external longitudinal layer of muscle over the rectum. This transition is illustrated here.

A rectangular window has been cut in this superficial layer of longitudinal muscle to demonstrate the underlying circular musculature. Lower down, the anterior portion of the rectal wall has been cut away in order to illustrate the formation of the sphincter and the attachment of the levator ani muscle. About 4 cm. meters above the anal margin, the circular muscle increases in thickness so as to form the internal rectal sphincter. The longitudinal muscle is continued down and is inserted partly into the levator ani and partly into the fascia around the anus.

The external sphincter is a voluntary muscle somewhat elliptical in shape, surrounding the anal canal and extending from the tip of the coccyx posteriorly to the perineum anteriorly. As illustrated, it is folded on itself at its lower extremity so as to form a superficial and deep layer of fibers. About midway of the anal canal the deep layer meets the internal sphincter. At this juncture there is a depression, not always discernible to the eye, but palpable to the finger. This line has been termed the "White Line of Hilton." On each side of the rectum the levator ani is shown forming the pelvic floor and above this the semilunar peritoneal folds which form the pararectal fossae are represented.

The levator ani, the external sphincter, the obturator muscle overlying the ischial bone form, on each side, an angular space known as the ischiorectal space. Laterally, the fossae of the hip joints are represented.



Musculature of the Lower Bowel
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OBSTRUCTION OF THE SIGMOID FLEXURE BY A LARGE GALLSTONE

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ILEUS caused by the impaction of a gallstone is exceedingly rare and occurs so seldom in ordinary surgical practice that its occasional observation merits particular interest. The experience of Martin[1] affords especially impressive evidence of the infrequency of the condition. A questionnaire which he addressed to a number of prominent surgeons of America elicited replies which indicated that among approximately half a million operations performed by them there were only sixteen instances of intestinal obstruction due to gallstones, or an average of one case in about 30,000 operations. In England, Mayo Robson[2] discovered four cases among 80,000 patients in four large hospitals. One infirmary recorded a single instance of intestinal obstruction by a gallstone in 50,000 admissions of patients. Barnard[3] found eight cases resulting from gallstone among 360 cases of intestinal obstruction encountered during a period of eight years in the principal hospital of London. Finally, a survey conducted under the auspices of the British Medical Association[4] revealed that impacted gallstone was the cause of the intestinal obstruction in less than 1 per cent of all cases of the latter reported within a certain year from seven hospitals.

A perusal of available literature on the subject shows that the terminal portion of the ileum, where the latter becomes narrower in the direction of the ileocecal valve, is the site of predilection of obstruction by gallstone, the duodenum and the jejunum, respectively, being less frequently obturated; while the colon in general and the sigmoid flexure specifically are apparently almost never affected. Thus, among fifty-two cases collected by Courvoisier[5] in 1890, the ileum was obstructed in thirty-three, the ileocecal valve in nine, the duodenum in eight and the sigmoid flexure in only two. In 1914, Wagner[6] prepared a tabular summary of 148 cases previously reported by various writers. Of these, eighty-one involved the ileum (fifty-three its terminal portion), thirty the jejunum, and nine the duodenum, while in fifteen the site of obturation in the small intestine is not stated. The colon was invaded in only thirteen of these cases but no instance of obstruction of the sigmoid flexure is adduced. A careful examination of contributions to the literature since the date of publication of the comprehensive monograph by Wagner[6] has failed to reveal a single reference to the sigmoid flexure as the location of the disturbance.

Individuals in the latter decades of life are particularly liable to this form of intestinal obstruction. The proportion of female to male patients is estimated widely at from 15:1 and 3:1, respectively, in contrast to the incidence of gallstones in women and men which is assumed to occur in the approximate proportion of 2 or 3:1.

According to statistics compiled by Wagner,[6] the mortality from ileus due to gallstone ranges from a maximum of 92 per cent to a minimum of 23 per cent, the latter figure relating exclusively to deaths from complications which followed extraction of the stone. Two major factors are believed to account for the excessively high general rate, namely, the advanced age at which patients undergo operation and the delay which is sometimes inadvertently allowed to occur between the onset of the obstruction and the institution of the appropriate

surgical procedure for its relief. It is the consensus of opinion of experienced surgeons that the prognosis is most favorable

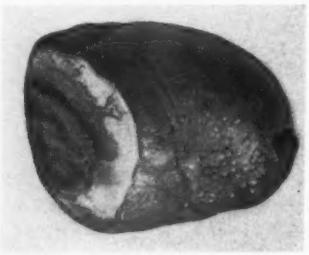

FIG. 1. Large gallstone which produced obstruction of the sigmoid.

when an operation is performed not later than the third day following the adoption of even a presumptive diagnosis.

Three possible portals of entry of gallstones into the gastrointestinal tract have been demonstrated and described: (1) A fistula between the gallbladder and the intestine resulting from antecedent cholecystitis, cholelithiasis, ulceration and erosion, with subsequent production of pericholecystitis and formation of adhesions between the gallbladder or gallducts and the adjacent viscera. While the perforation which develops within these adhesions is most frequent between the gallbladder and the duodenum, fistulae may occur also in the ileum as well as the large intestine. (2) A fistula of the choledochus into the duodenum. (3) Passage through the intact common duct and thence into the duodenum. It has been found that most gallstones enter by way of a fistula between the gallbladder and the duodenum. Among thirty fatal cases reported by Courvoisier,[5] twenty-eight resulted from cholecystoduodenal fistula, and two from fistula between the gallbladder and the colon. Of seventy cases contributed by Murphy and cited by Moore,[7] in which the route of the gallstone was traced, entrance occurred via a fistula between the gallbladder and the duodenum in thirty-six, the gallbladder and the ileum in twenty-five, the common duct and the duodenum in seven and the duodenum and the colon in one. However, of the several modes of invasion, passage into the duodenum through the intact common duct is the least frequent, although in extraordinary instances ileus from gallstone has occurred without evidence of biliary fistula. In a classic example quoted by Beam[8] and credited to Morgagni the common duct was dilated to the approximate size of the stomach by gallstones.

A consideration of the precise etiology of intestinal obstruction by gallstone is of paramount importance for its differential diagnosis from the other more familiar varieties. Since ileus caused by gallstone results from actual mechanical obstruction of the lumen of the bowel associated with spastic contraction of the muscular fibers of the latter, following relaxation of spasm and gradual migration of the stone along the intestine, the usually persistent symptoms of pain, vomiting and constipation which accompany the other forms of the disorder often assume a definitely intermittent character. Partial occlusion of the lumen by the gallstone may permit the escape of gas and distention and interference with the supply of blood may fail to ensue as in instances of complete obstruction. An antecedent history of cholelithiasis is indispensable for the establishment of even a provisional preoperative diagnosis of ileus due to gallstone. Unfortunately, the anamnesis rarely reveals evidence of previous disease of the gallbladder, although even if it does so the occasionally considerable interval which may have elapsed from the occurrence of the cholelithiasis to the onset of the ileus may obscure the relationship between the two incidents. Radiography sometimes yields shadows suggestive of gallstones, and in the absence of the history referred to may afford the sole basis for a diagnosis prior to operation. However, Gilman[9] warns that the use of opaque material administered by mouth may precipitate a condition of complete obstruction. As in other types of intestinal obstruction the white cell count is usually elevated but is not likely to be as high as in obstruction due to strangulation. Icterus seldom manifests itself, although it is noted when the

stone passes through the intact common duct. According to Powers,[10] there is usually no marked local tenderness but sensitiveness below the right costal margin in the region of the gallbladder is indicative of recent perforation, while generalized abdominal spasm points to general peritonitis.

The prognosis of ileus due to the presence of gallstone depends primarily upon early diagnosis and prompt surgical intervention. In this connection it should be remarked that very often patients exhibit intermittent obstructive symptoms which frequently increase in severity with recurrent exacerbations until complete obstruction occurs. The possibility of peritonitis constitutes an additional hazard of delayed operation. Vidgoff[11] attributes the relatively high mortality to the fact that the majority of patients are not operated upon before five to eight days after the onset of the obstructive symptoms. Balch[12] contributes an instructive comparison of figures for mortality according to duration of obstruction prior to operation. In his group of seventeen cases, only one of eight patients operated upon after the third day of obstruction survived, while of nine patients who underwent an operation during the first three days only four died.

It has been estimated that approximately 50 per cent of patients with ileus resulting from gallstone recover without operative aid, the stone being gradually propelled onward through the small bowel into the colon and outward by way of the rectum. Courvoisier[5] asserted that seventy of 125 of his patients were cured spontaneously by passage of the stones per anum. In the series presented by Wagner,[6] ninety-three patients passed the stone by rectum, 159 were operated upon and eighty-two died without operation. But these infrequent instances of recovery under expectant treatment should not be accepted as proofs of its efficacy. Surgery has always been and is still the universally recognized means for the relief of ileus from all causes. The condition of the patient, the degree of obstruction, the extent of the toxemia and the time of intervention are cardinal factors in the determination of the particular operative method which is to be employed. Enterotomy is preferred by most surgeons when only mild toxicity is present. The stone is carefully manipulated past the point of obstruction, the bowel is incised along its longitudinal axis above the stone and the latter is extracted. The bowel is thereupon sutured transversely in two layers of gastrointestinal sutures and the abdomen is closed without drainage. The segment of the bowel which contains the stone should be lifted out of the abdominal cavity and walled off prior to incision. However, if the obstruction is complete, the toxemia profound and the general state of the patient otherwise grave, the risk entailed by a protracted operation should be seriously contemplated. Here simple enterostomy with removal of the stone and establishment of adequate drainage is indicated. The stone should be extracted through a transverse incision in order to avoid the constriction of the intestinal lumen which occurs when a longitudinal incision is closed and inverted. Transverse closure is advocated when removal of the stone is effected by means of a longitudinal incision. Saline solution should be administered subcutaneously and intravenously both before and after operation to compensate for chlorides lost by vomiting.

When a faceted stone is encountered at operation, it is quite probable that there is another stone higher in the intestinal tract which should be extracted prior to closure. If the condition of the patient warrants it, a search should be conducted for this second stone, whose discovery and removal during the initial operation may render unnecessary a subsequent surgical procedure designed for the relief of secondary obstruction.

The following case from my own practice apparently represents the third instance of obstruction of the sigmoid flexure by a gallstone thus far recorded in the literature:

A married woman, aged 64, with a past general medical history of typhoid fever and

malaria, when seen on January 17, 1940, related that two and a half years previously she had been admitted to the hospital with symptoms suggestive of cholecystitis and had been treated there for alleged peritonitis localized in the right upper quadrant. Following her discharge she had experienced recurrent digestive disturbances and symptoms referable to the gallbladder. On the morning of January 14, 1940, she had been awakened by an urge to defecate, whereupon she became violently nauseated and commenced to vomit. Vomiting had since occurred from four to five times daily. Enema elicited only a small amount of feces and gas. Examination revealed a robust, somewhat obese female with a firm and moderately distended abdomen. There was no definitely localized tenderness, but general discomfort was manifested on palpation with some resistance to pressure in the left lower quadrant. Urinalysis showed 3 plus albumin, a few red blood cells, some white blood cells, hyaline casts and an occasional granular cast. Examination of the blood revealed 4,850,000 red cells and 11,400 white cells, with 96 per cent of hemoglobin. A tentative preoperative diagnosis of intestinal obstruction was based upon the failure of the bowel to empty itself properly, nausea, vomiting and abdominal distention. Malignancy of the sigmoid was for a time suspected but was ruled out by the absence of bloody stools and purulent discharge from the rectum.

On January 19, 1940, an operation was performed under spinal anesthesia with pantocain. The abdomen was opened by a median subumbilical incision, and the distended ileum, ascending, transverse and descending colon were exposed. Following the delivery of the sigmoid into the wound, a well defined foreign body present in the former was palpated and identified as a large gallstone. Propulsion of the stone along the sigmoid and into the rectum appeared impracticable, since it was feared that a forceful effort to pass the stone over the promontory might result in laceration of the bowel and involve the necessity for an operation in the rectosigmoid region, a procedure which would have proved difficult because of the obesity of the patient. Exploration of the right upper quadrant revealed a definite mass, obviously a fused pyloric end of the stomach or the duodenum with the gallbladder. There were numerous adhesions around this region, and apparently a fistula (either a cholecystogastrostomy or a cholecystoduodenostomy) existed between the gallbladder and the gastrointestinal tract. Sigmoidotomy was performed and a large gallstone was extracted. The longitudinal incision was thereupon closed with No. 00 chromic catgut and interrupted silk, a Penrose drain was provided and the abdomen was closed in the usual manner.

The postoperative course was uneventful, except for a slight infection of the wound which healed completely, and a transient psychosis of presumably toxic origin, similar in character and course to that said to have been experienced during hospitalization for the attack of disease of the gallbladder two and a half years previously. The patient was discharged in excellent condition on February 17, 1940, approximately four weeks after the operation.

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CARCINOMA OF THE AMPULLA OF VATER*

THREE CASES OF TRANSDUODENAL RESECTION

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INDIVIDUAL experience with this disease is necessarily limited by rarity. In large series of autopsies, its incidence lies somewhere between 0.03 and 0.06 per cent.[1,5,8] Several authors, notably Cohen and Colp,[4] Whipple,[15] Hunt and Budd,[9] and Allen,[1] have recently reviewed carefully and exhaustively the scattered records and previous reviews of other small series of radical resections with complete clinical discussions.

Twenty-two resections had been done in 110 cases collected by Outerbridge.[13] The reported resections have been conservatively estimated to represent less than 20 per cent of the cases of periampullary carcinoma.[9] Ninety-six patients in 193 case reports reviewed by Allen[1] had no operation, or had exploratory or palliative operations only, leaving ninety-six cases of radical resection. Unfortunately for adequate surgical treatment, the high grade pancreaticobiliary insufficiency produced by these obstructing tumors is extremely disproportionate to their malignancy and extent. Hanot's term, "pancreatico-biliary pylorus" aptly suggests the analogy with the stomach in regard to early obstruction and symptoms. By reason of its rarity and of diagnostic difficulties these tumors are undoubtedly frequently confused with the much more highly malignant, but later obstructing carcinomas of the head of the pancreas. It has been noted often, beginning with Crohn,[6] that many of them found at autopsy as the cause of the symptoms and of death, are small, freely movable, resectable tumors without metastasis.

Our cases presented no clinical features by which they might be distinguished from carcinomas of the head of the pancreas or stone impacted at the ampulla, except the finding of blood in the stools. Denechau[7] believed that biliary obstruction, indeterminate intestinal bleeding and intractable diarrhea might be the clue to the diagnosis. Crohn[6] stated that not only the entire absence of bile but also of pancreatic ferments in the duodenal contents indicated the ampulla as the site, blood being the clinching factor. Hunt made a strong plea for early exploratory operation in all cases of obstructive jaundice in which definite contraindications are absent. Cohen and Colp[4] quoted Petren's opinion that the first three weeks of obstructive jaundice was the optimum time for exploratory operation. Remissions may occur because of ulceration of the tumor.

CASE REPORTS

CASE 1. Mrs. N. F., No. 1690335, a housewife, aged sixty-three, was admitted to Cook County Hospital December 12, 1937, with complaints of progressive jaundice, and dull boring epigastric pain for four weeks, during which she lost fifteen pounds in weight. The pain was aggravated by eating and somewhat relieved by vomiting two or three times daily for the previous three weeks. Eight months before she had been in the hospital for three weeks with jaundice, chills, fever, dull, boring, nonradiating pain in the right upper quadrant, and a loss of weight, rapidly regained after the disappearance of the jaundice. She had felt fairly well in the "free interval."

* From the surgical services of Dr. River, Dr. McNealy and the laboratory of Surgical Pathology, Cook County Hospital, Chicago.

Physical examination showed an intensely icteric, emaciated white female who had a slightly enlarged smooth liver with a sausage-shaped, tense, tender mass below it. The urine was negative except for bile. Two of eight consecutive stools contained occult blood. The icteric index was 80. The diagnosis was obstructive jaundice, probably malignant.

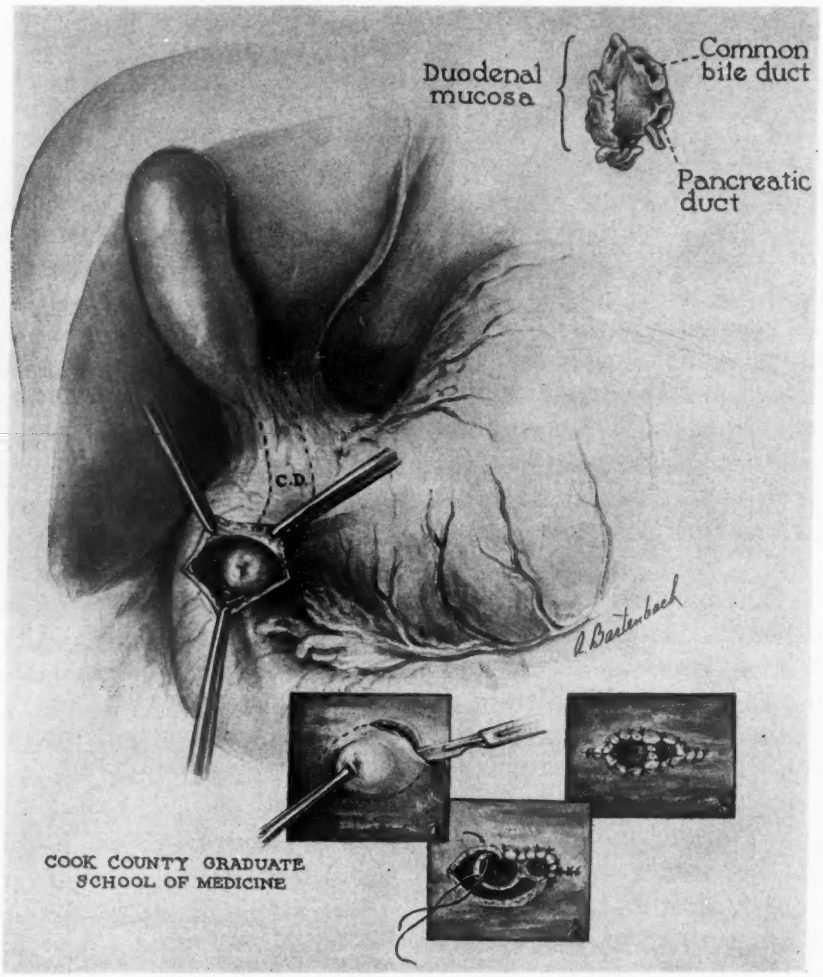

FIG. 1. Case 1. Appearance at operation.

At operation, January 8, 1938, (R. W. M.), a large, tense, gallbladder, an enormously dilated common duct and a rounded, firm mass in the posterior wall of the second part of the duodenum were found. The tumor was resected with adjacent duodenal wall, ampulla, common and pancreatic ducts. (Fig. 1.) The cut margins of the common and pancreatic ducts were united with each other and the duodenum. No drainage was introduced.

On the eighth day she began to vomit after having taken fluids well for four days. A duodenal tube, intravenous fluids and three transfusions controlled what seemed to be a duodenal obstruction. Occasional vomiting occurred until the twenty-second day. She was discharged February 20, 1938, feeling well, eating without distress and gaining weight. She remained well until April, 1939, when she noted weakness and anorexia. After three weeks, chills, fever and vomiting occurred, followed by jaundice, itching, occasional vomiting, clay colored stools and loss of weight. On readmission to the hospital, three weeks after onset of the jaundice, the coagulation time was seventeen minutes, bleeding time two minutes. The icteric index was 41; the gallbladder did not fill. There was no blood in the stools and the diagnosis was recurrence.

At operation, August 23, 1939, (R. W. M.), a distended gallbladder and common duct were found. There was tight constriction at the site of the anastomosis but no induration or glands felt. The diagnosis was anastomatic stenosis and cholecystgastrostomy was done. The jaun-

dice was noticeably clearing in four days, the course was uneventful and she was discharged on the fourteenth day, relieved of all complaints.

The preoperative diagnosis was impacted common duct stone.

At operation, July 20, on another surgical

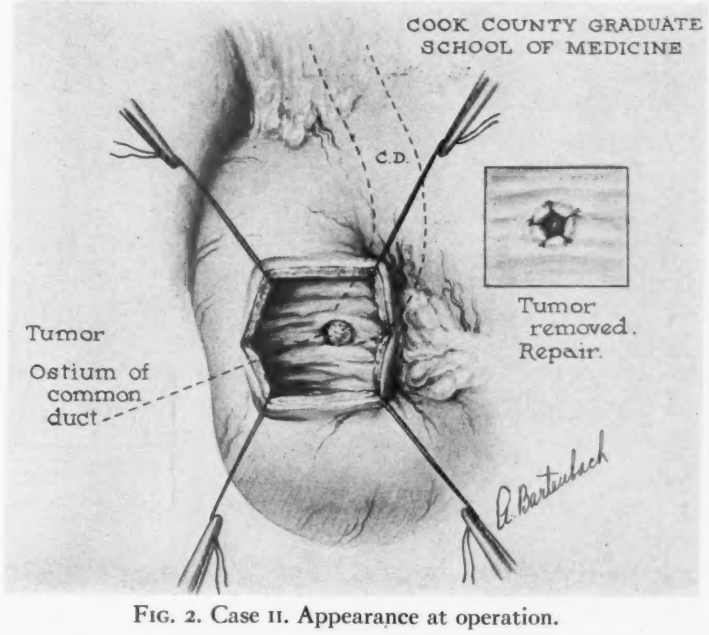

Fig. 2. Case II. Appearance at operation.

service, a distended gallbladder and common duct were found. Both were drained. The duodenum was negative to palpation; it was not mobilized. The fistula remained open until the twentieth postoperative day. Following closure jaundice developed rapidly with a tender, visible and palpable swelling of the gallbladder. The Junior intern, noting these features and continuance of the blood in the stool, made a diagnosis, by exclusion, of carcinoma of the ampulla of Vater.

Operation was performed August 15 (L. R.). The thin walled, distended gallbladder was covered with adherent omentum, stomach and duodenum. The common duct was not identified. There were two small abscesses between the adherent stomach and thickened hepatoduodenal ligament. Nothing abnormal was felt through the second portion of the duodenum. After mobilization, a small nodule was felt at the region of the papilla. Transverse anterior duodenotomy disclosed a round, slightly ulcerated, smooth nodule, 5 mm. in diameter, plugging a dilated opening. The pedicle was just inside the ampulla and the tumor had prolapsed through. A large probe passed it easily and allowed a free flow of green bile.

The circular resection included duodenal wall, tumor and ampulla. The pancreatic duct

On March 1, 1940, she stated that she had "indigestion," had to be careful of her diet, but had had no jaundice and had maintained her weight.

Case II. E. W., C. C. H., No. 37391, steam table attendant, married, aged fifty-five, was admitted to the hospital July 4, 1939. He complained of jaundice and itching for eight months, loss of fifty-eight pounds in eight months, pain in the right upper quadrant for six months and weakness and dizziness for one month. He was well until December, 1938, when jaundice began insidiously. Dull, boring pain was first noted two months later. Even though losing weight his appetite remained good until one month before admission, when he began to have much lighter colored stools and dark urine. During this last month he lost ten pounds, and weighed only 100 pounds. His past history was negative.

Physical examination revealed a well developed, poorly nourished white male neither acutely ill nor deeply jaundiced. His liver was palpable four fingers below the costal margin and was smooth and firm. Microscopic blood was found in three consecutive stools which contained small amounts of bile. The urine contained urobilin and bile. The icteric index was 75, blood cholesterol 284 mg. per cent and cholesterol esters 83 mg. per cent on July 7.

was not seen. The common duct was 1.5 cm. in diameter. It was sutured to the duodenal defect.

Completely clear of jaundice, and the wound healed, the patient, weighing 131 pounds, was discharged on the sixteenth day. Just before and just after discharge he had eight deep *x*-ray treatments through two portals.

On April 1, 1940, he weighed 155 pounds, looked well, felt well and stated he was eating everything his toothless gums could handle. There were no masses felt; the liver edge was impalpable. Rectal examination was negative.

On April 16, 1940, he returned to the hospital complaining of loss of appetite, epigastric distress, chills and fever, itching of the skin and constipation for two weeks. He had two chills followed by fever on the ward. The only positive physical finding in a complete work-up was a distended, tense, nontender gallbladder. No evidence of metastasis was present. Bile was

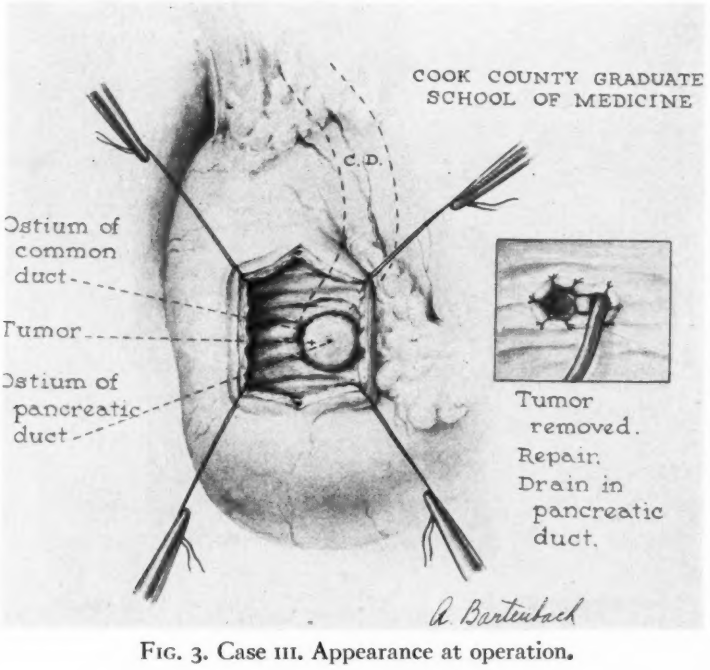

FIG. 3. Case III. Appearance at operation.

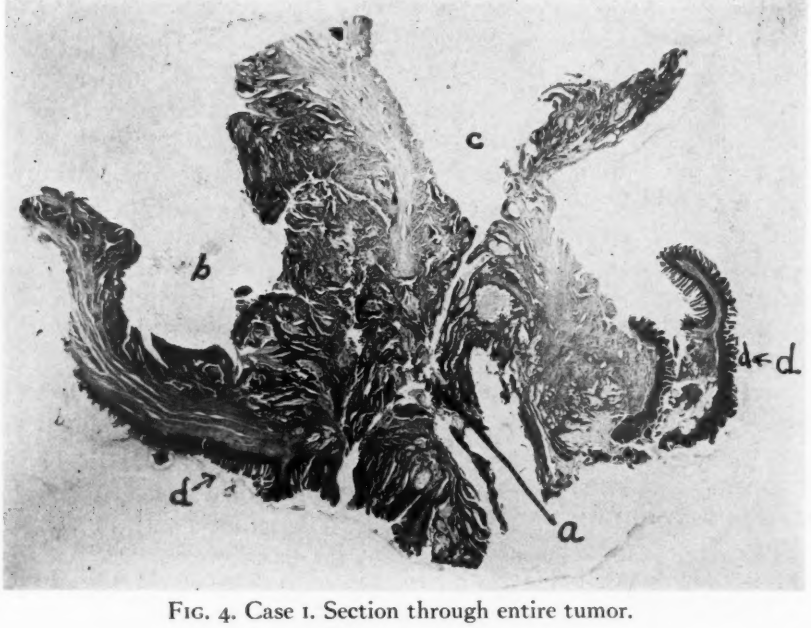

FIG. 4. Case I. Section through entire tumor.

found in the urine and stools. There was no blood in the stools. The prothrombin clotting time was 100 per cent. The diagnosis was cicatricial obstruction at the site of anastomosis with early ascending cholangeitis. Cholecystojejunojejunostomy by Whipple's method was done April 23. There was no palpable evidence of local recurrence or distant metastasis. Convalescence was uneventful. The jaundice had disappeared on the fourth day. The patient stated that all his symptoms had been relieved when discharged on the sixteenth day and that he felt better than for the two or three months before operation. He was operated upon on September 20, 1940, for severe duodenal obstruction. No glandular or hepatic metastases were felt. He has remained well except for occasional intestinal distress; on February 10, 1941, *x*-ray showed a well functioning stoma.

Case III. S. S., C. C. H., No. 50672, a waiter, single, aged fifty-five, was admitted to the hospital September 6, 1939, with complaints of jaundice, bloating and belching, and weakness for four weeks. Sharp right upper quadrant pain had been present for three weeks, radiating to both shoulders. He had lost ten pounds in the last two weeks.

Physical examination revealed a well developed, emaciated, deeply jaundiced, white male, appearing ten to fifteen years older than his stated age. He had a palpable, tender gallbladder. Bile was absent in the stools. The chemical test for blood was positive in five of eight consecutive stools. The icteric index was 50. The diagnosis was carcinoma of the pancreas or of the ampulla of Vater.

Operation was performed on September 29, (L. R.). A tense, thin walled, distended gallbladder and dilated common duct were found. There were firm small glands at the junction of the hepatic and cystic ducts and at the hilum of the liver, but no nodules in the liver. The pancreas was uniformly firm and enlarged. There was a 1.3 cm., hard, eroded, disc-like mass in the posterior duodenal wall, mesial to the common duct opening. (Fig. 3.) Wirsung's duct opened in the middle of this. The surrounding duodenal mucosa was edematous. Laterally, the mass overhung and obstructed the opening of the common duct, from which dark green bile flowed when a probe was passed. The mass was resected with surrounding duodenal wall and the lower portions of the separate ducts. These were sutured to each other and anastomosed to the duodenum, and 3 cm. of a No. 10 catheter placed in Wirsung's duct with the end hanging free in the duodenum.

The jaundice disappeared slowly. The gallbladder drain came out on the sixteenth day at which time there was still slight jaundice but much bile in the stools. Deep *x*-ray therapy was begun and he was discharged from the hospital thirty-five days after operation, having gained twelve pounds.

On May 24, 1940, he looked well and was not jaundiced. He had gained ten pounds since discharge. He could not eat fried or greasy foods without distress. Examination of the abdomen was negative, the liver margin was not felt and he stated that there was no pain. The stool contained no undigested fat nor blood and was well colored. Rectal examination was negative. He died September 25. Massive metastases into the mediastinum had been shown by *x*-ray. No autopsy was performed.

PATHOLOGIC REPORTS

Case I. N. F. Figure 4 is a section through the entire specimen. Sections are shown from the most proximal portion of the common duct and serially from the tumor proper in the ampulla of Vater. In the former section, the common duct was lined in places by a single layer of columnar epithelium showing slight papillary projections into the lumen. Embedded in the wall and particularly in the submucosa were large numbers of gland-like structures lined by tall columnar epithelium, in places several layers thick, with not infrequent mitotic figures. Some were atypical. These glands were surrounded by fairly dense accumulations of plasma cells, lymphocytes and a few polymorphonuclear leucocytes. Sections through the ampulla of Vater revealed numerous, irregular, gland-like structures (Fig. 5A) containing numerous atypical mitotic figures, and encircling and invading the wall of the pancreatic duct forming the polypoid structure already described. The stroma was heavily infiltrated with eosinophiles and lymphocytes. Some of the tumor glands were distended by a large amount of mucoid material.

Diagnosis. Mucus producing adenocarcinoma of the ampulla of Vater with invasion of the common bile duct and the pancreatic duct.

Case II. E. W. Sections at different levels revealed a portion of the tissue to be lined by duodenal mucous membrane. On tracing the mucous membrane as it approached the common duct opening it was lined by low columnar epithelial cells which infiltrated the submucosa and formed small and large irregular glands lined by cells which contained irregular hyperchromatic nuclei. (Fig. 5B.) In places the lining cells of the glands were several layers thick, and scattered atypical mitotic figures were seen. This tumor was associated with a moderate desmoplastic reaction which was heavily infiltrated by numerous lymphocytes and plasma cells. In one area the sphincter muscle of the common duct was infiltrated by tumor.

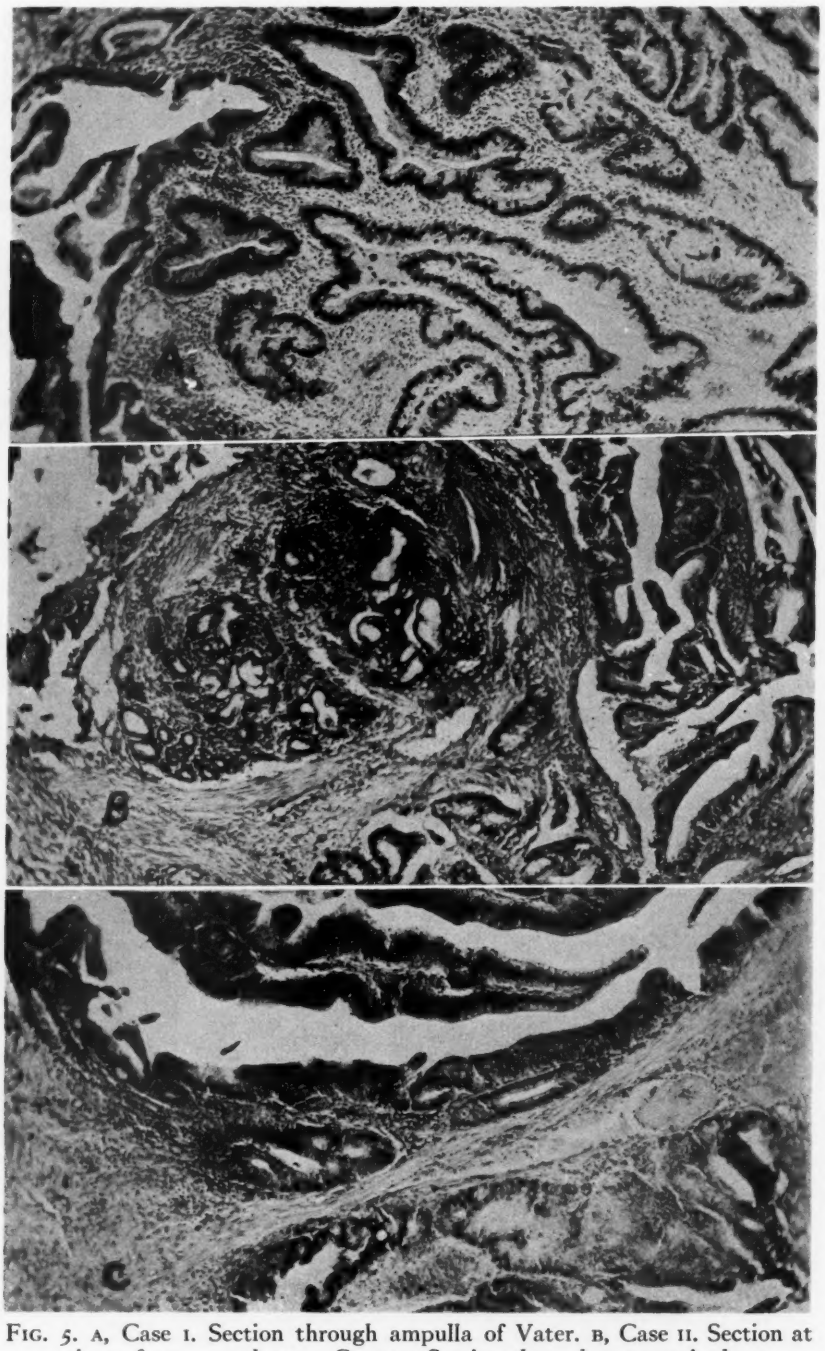

FIG. 5. A, Case I. Section through ampulla of Vater. B, Case II. Section at ostium of common duct. C, Case III. Section through pancreatic duct.

Diagnosis. Adenocarcinoma of the orifice of the common duct.

Case III. S. S. The tissue, 13 mm. in diameter, was button-shaped and had a small central depression 1 mm. in diameter. The free surface was granular. The thickest portion of the mass was 0.05 cm., the thinnest portion measured 0.03 cm. and encircled the thick portion from 2 to 3 mm.

Sections were taken through the entire thickness. The thin peripheral zone was lined by a mucous membrane characteristic of the duodenum. The thicker portion of the tissue was lined by irregular gland structures having numerous papillary projections, whose cells were large and several layers thick, with elongated and slightly irregular nuclei (Fig. 5C) and mitotic figures. The tumor tissue in places extended along the duct and invaded the muscle fibers surrounding it.

Diagnosis. Papillary adenocarcinoma of the pancreatic duct.

COMMENT

1. Complete work-up should be started on the jaundiced patient as soon as the history is written, and administration of vitamin K, bile salts, increased glucose, and blood, (as available), should begin at the same time.

2. *X*-ray, at present, offers little diagnostic help. The difficulties in showing such defects of the posterior wall of the duodenum as may be caused by these small tumors are enormous. No matter what methods are used, the anatomic irregularities and the height of the valvulae conniventes of the second portion are almost insuperable obstacles to good visualization. By the time the defects are visible the tumor is usually inoperable.[11]

3. Obstructive jaundice being demonstrated, particularly in the absence of pancreatic ferments in the duodenal contents and the presence of blood in the stools, surgical exploration should wait only upon adequate preparation of the patient.

4. In addition to the usual exploration of the gallbladder and ducts, palpation of the duodenum and pancreas, the duodenum should be mobilized and palpated, or opened, or both. It should be remembered that stones are an incidental finding in about 20 per cent of cases of this disease.

5. For the small, early tumors one-stage local resection seems still to be the procedure of choice. If the glands felt in Case II are malignant, the two-stage procedure could be no more useful than the operation performed. Hunt's patient, the case reported in 1935, lived twenty-seven months and died of extensive mediastinal and retroperitoneal metastases.[10] He has since twice performed the same operation for obstructing growths of the ampulla, one benign and one malignant. Both patients are alive and well, the one with carcinoma twenty-two months after operation. Emphasizing that he had had no experience with Whipple's[15] operation, he questioned whether extensive operation for carcinoma of the ampulla invading the head of the pancreas will be followed by results sufficiently good to justify its extent.

6. The pancreatic duct may be ligated if necessary. Whipple[15,16] and Brunschwig[2] have demonstrated the physiologic practicability of exclusion of the pancreas with block excision of the duodenum and the head of the pancreas. This two-stage resection is a notable contribution to the surgery of cancers of this region. However, excluding cancer of the pancreas, the remainder metastasize late and the metastases are distant as often as local. If the size of the growth and the extent of invasion of duodenum and pancreas indicate the futility of attempting one-stage local resection, the first stage of Whipple's operation should be done. If time is extremely important, it seems that the two anastomoses could be accomplished rapidly with Murphy buttons.

Excellent palliation with little danger of ascending cholangeitis may be expected from the cholecystojejunostomy described by either Lauwers,[12] Whipple[15] or Brunschwig.[2] One might then consider unhurriedly the advisability of undertaking the second stage. Adequately to evaluate and compared the one- and two-stage procedures, Whipple[16] predicated a sufficient

number of cases with five-year follow-ups.

7. Longitudinal anterior duodenotomy with transverse closure is suggested as compensation for the posterior resection.

CONCLUSIONS

1. Three instances of successful transduodenal resection of periampullary carcinoma with re-implantation of the ducts are recorded. Two required subsequent internal biliary drainage because of stenosis at the anastomoses.

2. Earlier and more frequent exploratory operation in obstructive jaundice is urged.

3. Duodenal mobilization and incision are advised if the history and course are suggestive, and no cause for the obstruction found by the usual palpation and probing.

4. Choice of operative procedure is discussed.

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CAUSALGIC BACKACHE

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JUDOVICH and Bates[8] have called our attention to the fact that low back pain may originate in the dorsolumbar area. In osteopathic literature the authors have mentioned that a pelvic tilt may cause backache due to a primary short lower extremity. This condition they treat by an elevation within the shoe and by osteopathic manipulation.

One type of back pain involves the lumbar muscles and especially the quadratus lumborum. Here, pain radiates along the twelfth rib due to twelfth dorsal and first lumbar nerve irritation and a clinical picture of asymmetrical muscle imbalance occurs. This group of cases comprises a definite clinical entity which can be separated from the vast group of patients suffering from back pain. The treatment is simple and effective.

This type of backache, produced by muscle imbalance, causes subjective symptoms because the imbalance, together with the muscle spasm, increases the tension within the quadratus lumborum fascia, producing direct pressure on the twelfth dorsal and first lumbar nerves. The irritation is manifested by pain with radiation along the course of these nerves. (Fig. 1.)

The trunk is maintained erect in equilibrium by the abdominals and quadratus lumborum muscles in front and the sacrospinalis muscles behind. Overaction or weakness of any group of these muscles will allow contractures to develop.

The abdominal muscles, due to lack of use, become weakened and the overworked sacrospinalis muscles become contracted with an increase in the lumbar lordosis. The pelvis, lacking the stabilizing effect of the abdominal muscles then inclines more anteriorly. Injury, a toxic focus or chronic stress, may cause the quadratus lumborum to become irritated, resulting in spasm. Contraction of the quadratus lumborum causes the last rib on the same side of the spine to deflect downward at a more acute angle. As the twelfth rib is drawn downward it also rotates forward, giving relatively a greater distance for the twelfth dorsal nerve to traverse from the intervertebral foramen to the subcostal groove. As a direct result of this shift there is produced increased tension in the nerve sheaths. In an effort to relieve the pain thus produced, the patient will assume a position of asymmetrical muscle imbalance and functional scoliosis appears. Following this uneven distribution of body weight a pelvic tilt results with abduction of the lower extremity on the side of the low crest and adduction of the lower extremity on the side of the high crest.

Other muscle changes then occur. On the the abducted side, the thigh rotates internally at the acetabulum and the foot pronates with a valgus of the heel. On the adducted side, the thigh shows little or no internal rotation and the foot little or no pronation. Another factor in maintaining the pelvic tilt is the pull of the pronated foot and internal rotation of the femur of the abducted extremity. (Fig. 2.)

We have chosen to label this syndrome, for want of a more appropriate term, causalgic backache. Causalgia, or pain of a burning nature, describes briefly the sensation these patients experience.

EXPERIMENTAL PRODUCTION OF CAUSALGIC BACKACHE

One of us, in an effort to prove the validity of this theory, made an experiment

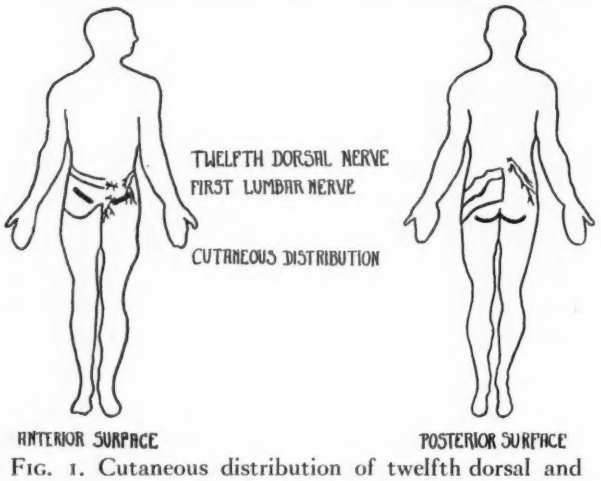

FIG. 1. Cutaneous distribution of twelfth dorsal and first lumbar nerves.

in an individual who had no history of previous back complaints. Preliminary clinical and Roentgen examinations were negative. An elevation of ¾ inch was added to the heel of the left shoe, and was worn at all times. A clinical examination was made with the adjusted shoes on. There was noted a pelvic tilt with the right side inclined downward. The spine showed a right dorsal, left lumbar scoliosis. The right thigh was abducted and the left thigh was adducted.

On the first day of the experiment there was a sensation of walking uphill on the adducted extremity. Most of the weight was borne on the abducted extremity (right), while the patient was walking and standing. (This was proved by having him stand with each foot on a separate spring balance.)

A notation in the diary on the third day disclosed that considerable aching was experienced deep in the buttocks. By this time it was impossible for the subject to walk with comfort unless the entire right lower extremity was internally rotated.

After one week, there was a sense of tightness and pulling in the dorsolumbar area on bending over; especially was this true on any attempt to straighten up. At this time definite tenderness was present paravertebrally in the dorsolumbar area and along the right twelfth rib. The right sacrospinalis muscles were spastic.

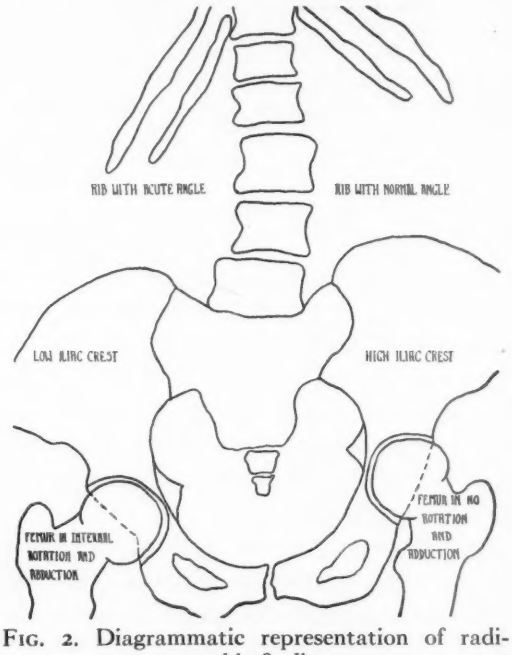
RIB WITH ACUTE ANGLE
RIB WITH NORMAL ANGLE
LOW ILIAC CREST
HIGH ILIAC CREST
FEMUR IN INTERNAL ROTATION AND ADDUCTION
FEMUR IN NO ROTATION AND ABDUCTION

FIG. 2. Diagrammatic representation of radiographic findings.

Following three weeks' activity in this position, subjective pain was present radiating around the right side at the level of the twelfth nerve distribution. Hyperesthesia was present in the groin and along the right side of the chest. Night pain in these areas had been present for some time.

After the elevation was removed and exercises instituted, the symptoms disappeared in two weeks.

History. The history of these patients is quite characteristic. They have suffered for years with a pain in the low back area. They localize it, however, by placing the hand over the crest of the ilium or midlumbar region. Pain is unilateral. If pain is right-sided, many of the patients have had appendectomies, gall-bladder surgery, or urologic instrumentation without relief. The pain is described as aching, burning, tearing apart, boring, or stabbing in nature. These patients are unable to get comfortable on going to bed and they twist and turn for ten to twenty minutes to get relief. This pain awakens the patient at

TABLE I

Case	Sex	Age	Chief Complaint	Duration of Symptoms	Type of Individual	Previous Treatment	Elevation of Heel, Inches	X-rays		Foci	End Result
								Positive for Syndrome	Osseous Lesions		
A. G.	M.	48	Pain right back	2 years	Slender	Physiotherapy	½	Yes	None	Teeth	No pain. Returned to WPA work
C. P. H.	F.	38	Pain right back and groin	4 years	Heavy	Physiotherapy, foci removed, support	½	Yes	None	None	Cured
L. M.	F.	40	Pain right back and groin	5 years	Slender	Kidney studies, fracture 1st. lumbar vertebra, 1930	⅝	Yes	None	Teeth	Cured
A. R.	M.	28	Pain right back	1 year	Slender	Physiotherapy	½	Yes	None	None	Cured
M. R.	F.	35	Pain left groin	10 years	Slender	Foci removed	½	Not done	.....	Teeth	Relieved
M. C.	F.	39	Pain right lumbar area	6 years	Slender	Laparotomy, physiotherapy	½	Yes	None	None	Cured
L. E.	M.	39	Pain right low back	?	Slender	None	⅝	?	Scoliosis	None	Cured
E. B.	M.	41	Pain right low back	4 months	Slender	Physiotherapy	⅝	?	None	Teeth	Relieved
L. E.	F.	41	Pain right groin and short ribs	3 years	Slender	Urological studies, physiotherapy	⅝	Yes	None	None	Did not carry out treatment
A. P.	M.	30	Pain in left upper back	8 months	Slender	Physiotherapy	¾	Yes	None	None	Relieved
A. A.	M.	45	Pain right short ribs	4 months	Slender	Physiotherapy	½	Yes	None	None	Relieved. Returned to WPA work
R. B. H.	F.	40	Pain right short ribs	9 years	Slender	Physiotherapy, Ober operation	½	Yes	None	None	Cured
A. T.	M.	30	Pain right groin	1 year	Slender	Physiotherapy	½	Refused	.....	None	Unknown
H. H.	F.	44	Pain right groin	1 year	Slender	Physiotherapy	½	Refused	.....	None	Refused treatment
R. B.	M.	40	Pain right low back radiating to groin	1 year	Slender	Physiotherapy	¾	?	None	Teeth	Cured
E. J.	F.	44	Pain right low back radiating to groin	15 weeks	Slender	None	⅝	Refused	.....	None	Relieved
J. G. M.	M.	41	Pain left low back radiating to groin	7 months	Slender	Physiotherapy	½	?	None	None	Relieved
D. P.	F.	24	Pain right back radiating to groin	3 months	Slender	Physiotherapy	½	?	None	None	Relieved
A. B.	F.	20	Pain right low back	3 months	Slender	Physiotherapy	½	Yes	None	None	Cured
R. D.	F.	39	Pain left low back radiating to groin	3 years	Slender	Physiotherapy	½	Yes	None	None	Relieved
G. L.	F.	33	Pain left low back	4 months	Slender	None	½	Refused	.....	None	Unknown
H. M.	M.	40	Pain right dorso-lumbar area	1 year	Slender	Physiotherapy	½	Yes	None	None	Cured
G. B.	F.	36	Pain right dorso-lumbar area	1 year	Heavy	Physiotherapy	½	?	Congenital anatomies	None	Some relief
Dr. P. E.	M.	39	Pain right dorso-lumbar area	2 years	Slender	Lift on heel	⅜	Yes	None	None	Cured
L. L.	F.	37	Pain right upper back radiating to groin	2 years	Slender	Physiotherapy	¾	Yes	None	None	Cured
H. C. B.	M.	40	Pain right upper back	1 year	Slender	Foci removed	½	None	None	None	Questionable
G. R.	M.	35	Pain left low back	4 weeks	Slender	Physiotherapy	½	None	.....	Teeth	Questionable
G. M.	F.	47	Pain right dorso-lumbar area	1 week	Slender	None	½	Yes	None	None	Questionable
M. M.	M.	35	Pain left dorso-lumbar area	3 years	Slender	Various	½	Yes	None	None	Cured
Dr. M. L.	M.	36	Pain left dorso-lumbar area	2 years	Slender	None	½	Yes	None	Teeth	Cured

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night, it begins near the midline posteriorly and usually radiates anteriorly when he arises. Lying on the hypersensitive skin area produces the night pain. Coughing, sneezing, or missing a step while walking gives severe pain that frequently doubles the patient up. Also, pain may be brought on by bending over the washbasin in the morning or bending over to do any type of work. In addition, there may be radiating pain into the thigh posteriolaterally, over the lumbosacral area, or over the upper gluteal area.

Examination. Examination of all patients reveals spasm of the lumbar muscles of varying degree, with limitation of motion of the spine in all directions. There is an increased lumbar lordosis. Scoliosis is present on standing, but disappears on lying down. The pelvis is tilted and on the low side there is abduction of the lower extremity, internal rotation of the thigh, and marked pronation of the foot. On the high side of the pelvic tilt there is adduction of the lower extremity, little or no rotation of the thigh, and little or no pronation of the foot. (The rotation of the thigh on the low side may be overlooked if the patient is examined with the thighs in external rotation.)

Hyperesthesia to pinching and poking of the skin is present over the cutaneous distribution of the twelfth dorsal and first lumbar nerves. There is tenderness along the twelfth rib, especially at exits of nerve trunks through fascia or muscle. This can be elicited easily by pressing upward on the lower edge of the rib. There is tenderness and hyperesthesia parallel to Poupart's ligament, on the upper inner aspect of the thigh, and over the twelfth dorsal and first lumbar transverse processes paravertebrally.

Leg length should be measured. Elevations of varying thicknesses under the heel of the side of the low iliac crest should correct the pelvic tilt and reëstablish normal posture. The patients will immediately feel more secure in their balance and comment on this fact without questioning.

Treatment. If the heel on the abducted extremity is raised by an elevation sufficient to overcome the pelvic tilt the quadratus lumborum is relaxed, the rib returns to its normal position, the scoliosis is corrected, and the internal rotation of the thigh disappears. Exercises are given to strengthen the abdominal muscles and weaken the sacrospinalis group.

Radiographic Examination. Roentgenograms are taken in the usual manner to rule out any abnormality such as structural scoliosis, arthritis, etc. When causalgic backache is diagnosed clinically, the routine *x*-ray films are supplemented by special examinations described in detail below. Conversely, this syndrome may be suspected if anteroposterior upright films of the dorsolumbar spine and pelvis show an acute angle of the twelfth rib, low iliac crest, and low femoral head on the same side. (Fig. 3.)

We perform the Roentgen examination as follows:

1. A supine film is made in the anteroposterior projection of the lumbosacral spine including the lower two dorsal vertebrae. It is important that the subject be adjusted on the table so that the spine is straight.

2. A film is made of the same region with the patient in the upright position, using the Potter-Bucky diaphragm. The position of the patient, here too, is important. The shoes are removed and the feet are placed 4 inches apart and parallel. The patient is asked to stand with the weight equally distributed.

3. This examination is optional. The film is taken with elevations varying from ¼ to ¾ inch in thickness placed under the heel of the side of the low iliac crest. This is done as in 2.

Landmarks. 1. *Costovertebral Angle.* To determine one side of this angle, a line is drawn between the inferior articular margin and the inferior border of the twelfth rib at the junction of the outer and middle thirds. The other side of this angle is formed by a line drawn between the inferior

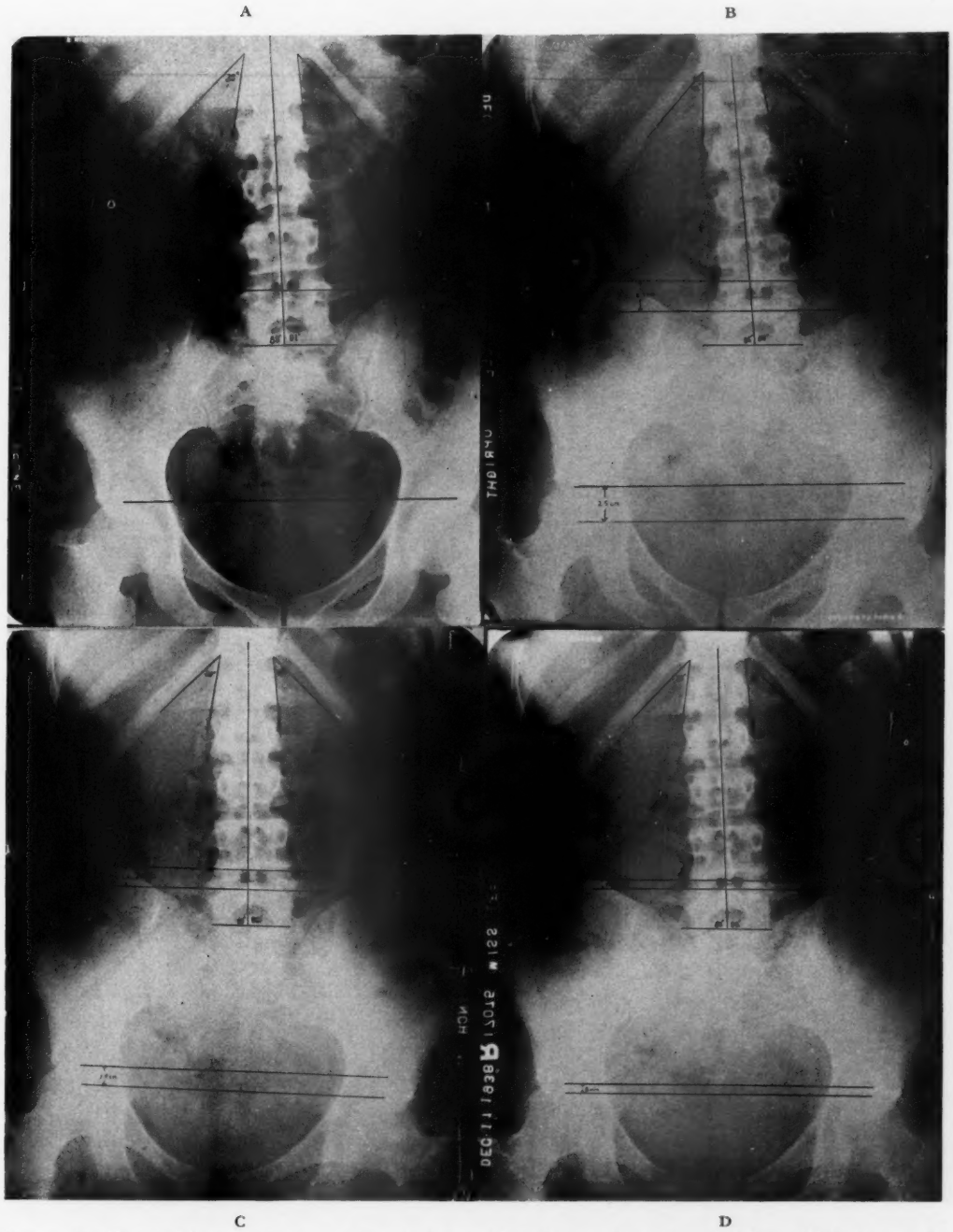

FIG. 3. Radiographic examination of typical case; female, aged 34, complaining of left lower abdominal pain and backache for five years. A, supine film, showing equal costovertebral angles, negligible deviation of axis of lumbar and level crests and femoral heads. B, upright film showing acute left costovertebral angle, deviation of lumbar spine towards the right, and low left iliac crest and femoral head. C, upright film with a ½ inch elevation under the left heel showing a partial correction of the deformities. D, upright film with a ¾ inch elevation under the left heel showing almost complete restitution to normal posture.

articular margin of the twelfth rib and the superolateral margin of the second lumbar vertebra.

2. *Angle of Deviation of the Axis of the Lumbar Spine.* A vertical line is projected from the midpoint of the spinous process of the twelfth dorsal vertebra to the same point of the first sacral segment. A horizontal line is drawn parallel to the bottom of the film through the spinous process of the first sacral segment. The angles formed by these lines are measured. The tilt of the spine, either to the left or right, is expressed in degrees by subtracting the smaller angle from the larger.

3. *Level of the Iliac Crests.* Lines are drawn parallel to the base of the film (or perpendicular to the side of the film) passing through the highest point of each iliac crest. The distance between these two parallel lines is measured.

4. *Level of the Superior Articular Margin of the Femora.* The procedure here is identical with that of 3, the only difference being that the uppermost point of each femoral head is selected as a guide for the parallel lines.

5. *Other Points to Be Noted on the Examination.* (*a*) Postural scoliosis of the dorsolumbar spine; (*b*) rotation of the pelvis; (*c*) abduction and adduction of the femora; (*d*) internal rotation of the femur on the side of the low crest.

REPORT OF CASES

We have treated thirty cases conservatively. The etiologic factors were: injury to the back in ten; focal infection in eight; and no known cause in the remainder. The pain was right sided in twenty-two cases and left sided in eight. Ages varied from 20 to 48 years. There were fifteen females and fifteen males. The type of individual affected was the slender herbivorous type in twenty-eight cases and the stocky carnivorous type in two cases.

The elevation of the heel was usually ½ to ⅝ inch. The elevation was worn for three to four months and then lowered one-half for three to four more months. Some patients, on raising the heel, develop pain in the thigh along the adductor muscles on the opposite side and in the gluteal area on the same side. The pain is usually relieved in two to three weeks and the hyperesthesia in six to eight weeks.

Exercises are started when the pain begins to subside and are continued daily for six months.

A typical case history follows:

M. L., male, complained of pain of "raw" nature in the left back, radiating to the lower abdomen just above the groin. This had existed two years. The pain awakened him in the morning. Examination revealed a pelvic tilt to the left, scoliosis of the spine, slight increase of the lumbar lordosis, hyperesthesia over the cutaneous distribution of the twelfth dorsal nerve, internal rotation of the left femur with valgus of the left heel, and no muscle spasm in the lumbar muscles.

SUMMARY

Another concept relating to a specific phase in the backache problem is presented. A mechanical theory based on muscle imbalance is advanced to explain the clinical and roentgen findings. The patients complain of an upper lumbar backache that is aggravated at rest, awakens them at night, and is accompanied by pain that radiates along the last rib and to the groin. The clinical examination reveals an increased lumbar lordosis, postural scoliosis, a pelvic tilt, abduction and internal rotation of the femur on the side of the low iliac crest, and adduction of the thigh on the side of the high iliac crest. There is tenderness and hyperesthesia over the cutaneous distribution of the twelfth dorsal and first lumbar nerves. The treatment consists of elevation of the heel on the side of the low crest and muscle exercises. The roentgenographic examination confirms the clinical findings when the upright films reveal an acute costovertebral angle and a pelvic tilt.

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FACTORS IN THE ETIOLOGY OF CHRONIC NONCALCULOUS CHOLECYSTITIS

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THE increasing literature and research on the syndrome of noncalculous cholecystitis shows that the etiology is based on a multiplicity of factors any one or a combination of which may be present in a given case. It is the purpose of this paper to fit together the available information in order to produce a basis on which a therapeutic program may later be constructed. There are three main etiologic factors for consideration in a study of noncalculous cholecystitis: (1) pathologic, (2) mechanical and (3) physiologic.

The extent of the pathologic process in the noncalculous gallbladder is quite variable as described by the classification of Graham and Mackey and the work of Brown. The most frequently occurring chronic pathologic conditions are (1) the minimal lesion, (2) chronic catarrhal cholecystitis, (3) chronic fibrous cholecystitis and (4) cholesterosis. Lahey stated that a fibrosed and contracted gallbladder is not itself the factor which causes stones in the ducts, but rather the conditions that bring about contraction of the gallbladder are the causative factors in the production of stones within the ducts. In 4 per cent of his cases in which stones were removed from the common duct, none were found in the gallbladder.

The pathologic changes in the noncalculous gallbladder range from that of a nearly normal looking organ to one which is extremely infected and fibrosed. Foss, in discussing the needless cholecystectomies, stated that any pathologist possessing a keen imagination and an inordinate desire to support the surgeon may find trouble in any gallbladder. MacCarty stated that diseases of the pancreas, duodenum, common duct, liver, hepatic flexure, transverse colon, stomach and appendix are often in themselves responsible for signs and symptoms which simulate gallbladder disease even though stones are found roentgenologically. In studying a series of 21,523 cases, he found that only 65 per cent of the surgically removed gallbladders contained stones. The presence of pathologic states other than infection in the absence of stones, such as papillomas, malignancies, diverticula, etc., may account for the necessity of surgery. This author stated that since many anatomically and functionally normal gallbladders do contain stones, it is quite likely that the presence of stones alone is not indicative of the necessity for surgery.

In the differential diagnosis of noncalculous cholecystitis, Essenson warned that duodenal ulcer on the posterior wall must be ruled out. Bochus, Shay, Willard and Pessel demonstrated that cholesterol crystals and calcium bilirubinate in bile "B" are pathognomonic of cholecystitis while the cholesterol crystals are highly suggestive of stone formation; when white blood cells are present, infection is indicated. Kanuth found the greatest percentage of cures following cholecystectomy in those cases reported as normal gallbladders. He stated that histologic changes in the wall of the gallbladder are not always an accurate index of the symptoms that the organ has produced or of the benefit that may result from operation. In a microscopic study of the gallbladder in these cases, 25 per cent of the noncalculous group were reported as normal.

Wolfer, in describing the relation of biliary stones and pancreatic regurgitation,

was convinced that acute necrosis, acute gangrenous, and also some cases of chronic cholecystitis with or without stones, are caused by a reflex flow of pancreatic juice into the gallbladder. Wakely stated that dental sepsis and chronic infection of the appendix are important factors in the etiology of gallbladder disease, for there can be little doubt that streptococci may spread via the blood stream from both of these sites to the walls of the gallbladder and set up chronic cholecystitis. Hodges and Lampe explained that major inflammation of the gallbladder occurred in 80 per cent of cases of nonvisualization.

The bacteriology of noncalculous chronic cholecystitis is variable. Aronsohn and Andrews, quoting Magner and Hutchinson, noted that Bacillus coli is the most common organism in the cavity of the gallbladder, while streptococci are found more often in the gallbladder walls. These authors showed that experimental cholecystitis has incriminated the typhoid bacillus, streptococcus, staphylococcus and Bacillus pyocyaneus. They also found that intravenous injection of most strains of bacteria did not cause cholecystitis unless some trauma was added to the wall of the bladder. The injection of bile and bile salts intravenously caused active gallbladder inflammation.

Alvarez and his co-workers found living bacteria in the walls of 57 per cent of the noncalculous gallbladders examined. Blalock obtained positive cultures from 58 per cent of cultures with Bacillus coli being predominant in occurrence and Bacillus typhosus ranking second. In contradistinction to these findings, Nickel and Judd found 71 per cent of strawberry gallbladders and the majority of all chronic cholecystitis cases were sterile unless complicating factors were present. Lowenburg and Mitchell described eight cases of cholecystitis in childhood in which a parasite, Lamblia intestinalis, may have been of etiologic importance.

Kasselberg found in the literature that bacteria of most every type have been reported as cultured from the gallbladder wall and bile. He found that the streptococcus was most often accused while other organisms as staphylococcus, Bacillus welchii, Bacillus coli and Bacillus typhosus were reported. He confirmed the work of Aronsohn and Andrews that injection of bacteria plus trauma will cause cholecystitis. Coller and Jackson emphasized the point that long standing gallbladder infection may cause structural changes in the liver with resultant disturbance in carbohydrate metabolism. Schmidt reported a case of emphysematous cholecystitis caused by Bacillus perfringens. He considered that bacteria found in the gallbladder fall into two groups: (1) head group to which the streptococcus viridans family belong, and (2) the colon group embracing the colon, typhoid, and gas producing organisms. However, Connell stated that sterile bile does not mean a normal gallbladder wall.

Graham stated that in chronic cholecystitis, the liver often presents a microscopic picture practically identical with that of early cirrhosis. Blalock found enlargement of the liver in 22 per cent of his cases. Deaver and Bortz found involvement in 3.5 per cent of noncalculous cases.

Mentzer showed that cholesterosis is present in 37 per cent of gallbladders seen at necropsy and in 22 per cent of surgical specimens. However, he concluded that early cholesterosis may remain for years without progression and therefore surgery is not indicated in all cases.

Judd and Priestley stated that associated removal of the appendix at the original operation did not seem to make any difference in the end results of cholecystectomy. In a study of 346 cases of cholecystectomy, Brown showed that associated appendectomy of 186 cases demonstrated four acute; nine subacute; and 109 chronic appendices, while fifty-nine were normal. Eighteen of the infected specimens contained fecaliths. The operative findings showed thirty with marked adhesions, four with Lane's kink and fifteen were described as retrocecal. Kanuth, in his comparative study, did not

explain his cures in the cases with normal cholecystogram except to state that perhaps incidental appendectomy was responsible. Muller wrote that chronic appendicitis is often difficult to differentiate. Mackey concluded that associated appendectomy did not improve the results of cholecystectomy in his series.

Lawrence and Warren call our attention to the fact that the muscular tunic of the gallbladder is composed of smooth muscle and, therefore capable of hypertrophy. They compared normal gallbladders at autopsy examination with surgically removed organs, and they found the average thickness in normal ones to be .16 mm. compared to .54 mm. in gallbladders showing pathology. Rokitansky-Aschoff sinuses were found three times in the normal ones compared with sixty times in the pathologic organs. These sinuses are usually described as mucosal diverticula or herniations through the muscular layer. The authors found that as cholecystitis increases, muscular hypertrophy becomes more marked until finally erasure of rugal pattern of the mucosa occurs.

MECHANICAL FACTORS

The mechanical factors are variable but may have a direct or indirect effect on the gallbladder. Anatomical variations in the length, caliber and position of the cystic duct may account for clinical symptoms. Congenital variation in the gallbladder structures have been shown to play a part in the etiology of the noncalculous syndrome.

Meeker (1920) analyzed 400 cases in which bands were found in various locations in the abdomen. In this group, 140 cases (35 per cent) involved the gallbladder, 16 per cent bound the duodenum and gallbladder together and 13 per cent involved the liver in addition to these two organs. Three per cent had bands binding the gallbladder and stomach together while another 3 per cent involved the liver as well. Bands occurring between the colon and gallbladder were the most common of all and 47 per cent of 140 cases had cholecystocolic adhesions. Another 18 per cent showed bands involving the liver as well as the foregoing organs. These bands occurring as mechanical factors may involve the duodenum, stomach, liver and colon or any combination of two or more structures without involvement of the gallbladder, yet they produce symptoms characteristic of the noncalculous cholecystic syndrome. Meeker noted that the greatest incidence of bands occurred among women between thirty-five and sixty-five years of age. This compares with Brown's analysis of 346 noncalculous gallbladders in which 92 per cent were found between twenty and sixty years of age, 93 per cent being females. The average age in this whole group was 41.06 years. Meeker stated that when bands involve both the stomach and the gallbladder, pressure and traction downward to the left over the pyloric end of the stomach produces pain in the gallbladder area as well as direct pressure by the finger tips. The diagnosis may be missed or called an ulcer because of this local tenderness.

Meeker found that roentgen examination may demonstrate dilation of the duodenum behind the bands with delayed emptying time. Consideration of this mechanical aspect of pericholecystic bands involving the duodenum may explain Finney's observation of many years ago that in those cases with noncalculous cholecystic syndrome the duodenum was dilated, thin walled and inconstantly associated with changes in the stomach and pancreas. He noted this in patients with a so-called neurotic taint.

That obstruction of the cystic duct may cause the symptoms of cholecystitis has been expressed by Cole. He stated that many cases of so-called cholecystitis are dependent upon obstruction of the cystic duct for manifestations produced and that this theory of the pathogenesis of gallbladder disease by no means can be dropped entirely. Severe angulation stenosis of the duct and anomalous (Heisterian) folds seem to be capable of producing

symptoms which are so serious as to demand relief by surgery.

Brown showed by his analysis of 346 cases that in 124 out of 164 patients showing adhesions about the gallbladder, 75 per cent were cured or improved by cholecystectomy. This exceeds the final results for the entire series by 5 per cent. It has been shown in the past that gonorrhea may invade the pelvis and spread to the upper quadrants of the abdomen to produce "violin string" adhesions. Perhaps this may account for some of the cases in women. However, Meeker considered that bands may be embryonal structures, the result of evolutionary development or toxic processes. Recently, Verbrycke described a new syndrome due to adhesions between the gallbladder and hepatic flexure of the colon. He stated that the gallbladder may concentrate and empty freely but that the weight of the dragging colon produces the symptoms of the gallbladder syndrome. The specific test of this author includes the simultaneous examination by dye and barium meal; if the colon follows the contracting gallbladder after a fatty meal, the shadows remaining close together, the diagnosis is nearly 100 per cent accurate.

General observations of patients in adult life, especially females, show that many begin to take on weight about the age of thirty or comparatively about the time of the greatest incidence of this noncalculous gallbladder syndrome. The parts of the body to show increased fat deposits first are the mesentery and omentum. The increased weight along the intestinal tract, then, could conceivably produce a drag on surrounding organs or tissues to account for a mechanical factor in the production of dyspeptic symptoms. The symptoms could then be intensified in the presence of congenital or anomalous bands or pericholecystic adhesions.

Kruse, in discussing the dyspeptic syndrome, stated that mechanical irritation of the gallbladder against the duodenum may account for the symptoms. Brown theorized that adhesions about the gallbladder could prevent emptying of the organ by obstructing or binding the organ to the extent of neutralizing its contractile powers required for evacuation.

One finds in the literature much discussion concerning stasis as an etiological factor in gallbladder disease. Actually, the explanation of gallbladder disease on the basis of stasis without qualification is no more accurate than making a diagnosis of rheumatism in a patient with joint or muscle symptoms without making a real attempt at diagnosis. Stasis, however, is a real thing when it is caused by pathological changes in the gallbladder wall or some mechanical factor such as adhesions, bands, angulations, or anomalies, preventing the outflow of bile from the organ. There is convincing evidence that these infrequently discussed points in the foregoing paragraphs explain symptoms of many cases in the presence of an apparently normal gallbladder.

PHYSIOLOGIC FACTORS

Recent years have brought to light many new and important facts in the physiology of the gallbladder and its ducts. Ivy and others have done much to further this study but many things are yet to be discovered. Many of the greatest advances in the knowledge of gallbladder physiology have been produced since the introduction of the Graham-Cole test in 1924.

Paulson considered that three pathologic-physiologic processes follow a disturbed sphincter of Oddi: (1) increased activity of the gallbladder and ampulla with rapid emptying—the hyperkinetic type of evacuation, (2) contraction of the gallbladder against spasm of the sphincter resulting in bilary colic—hypertonic dyskinesia, and (3) atonic gallbladder with a spastic sphincter producing a heavy aching sensation. Kanuth, after a comparative analysis of one hundred cases each of cholecystitis with and without stones, believed that the great majority of unimproved patients in the stoneless group must be explained on the basis of physiologic

changes and altered function. Thornton, in quoting Rehfuss, stated that there is convincing evidence of the relationship between heart disease and gallbladder disease since 10 per cent of the cases giving symptoms suggestive of anginal disease were relieved by surgery of the biliary system.

Disturbances of physiology that may play a part in biliary disease do not necessarily affect the gallbladder alone. Schwartz and Herman found obesity in 52 per cent of gallbladder cases and in 56 per cent of heart cases, with 68 per cent of his obese patients with gallbladder disease showing heart disease. Willius and Fitzgerald reported an incidence of heart disease in 39 per cent of a series of 596 gallbladder cases, and of these 75 per cent were of the degenerative type with obesity. Bearse discussed the relationship of obesity and gallbladder disease in patients under thirty years of age and noted that only 19 per cent were overweight, 74.6 per cent average weight, and 6.3 per cent were noticeably thin. In respect to obesity as a disturbance of physiology in gallbladder disease, Wakely described the suspected patients as "fair, flabby, fat, fertile, flatulent, females of forty."

Twiss wrote that gastric acidity is disturbed in 75 per cent of patients with gallbladder disease and he concluded that achlorhydria is an important contributing factor to biliary infection. Brown, in his study of 346 cases, however, found only two with hypochlorhydria and four with achlorhydria.

DeCourcy found the blood iodine in cholecystitis, hepatitis and obstructive jaundice to be above the normal level of 3 to 6 micrograms per 100 cc. The average values in chronic cholecystitis in the presence of stone was 16.6 micrograms per 100 cc. This author concludes that iodine metabolism is a function of the stellate cells of Kupffer.

Boland, in making a comparative study of gallbladder disease in white and negro patients, concluded that physiological factors such as idleness and lack of exercise together with excessive eating and drinking account for a ten times greater incidence in white than in colored persons.

The question of cholesterol metabolism is not settled. Some authorities claim that cholesterol is absorbed by the gallbladder mucosa. Others claim that it is not absorbed but mainly prepared for use by the body. Twiss and Barnard stated that a disturbance of cholesterol metabolism, although generally conceded to be a major contributing cause in the formation of stones, is as yet a little understood phenomenon. T. R. Brown, however, wrote that there is increasing evidence that the intake of lipoids by mouth plays little or no part in cholesterin metabolism. Twiss and others explained that an increased concentration of cholesterol in the presence of infection or stasis may account for the formation of stones. If this is the situation, it could hardly be said that the disturbance of cholesterol metabolism causes the stones, but actually the disturbance is the result of preexisting pathologic factors. This comment is supported by Doran and others in stating that the finding of crystals in the bile is not pathognomonic of stones but is evidence of pathology in the biliary tract. The statement can be found in the literature that hypercholesterolemia is usually associated with gallstones.

DISCUSSION

In a previous study of the noncalculous disease syndrome, the author showed that many patients having had poor results from cholecystectomy had their medical records extended to include many other diagnoses during periods of six months to seven or more years after operation. These diagnoses include myxedema, psychoneurosis, neurasthenia, achlorhydria, dyskinesia, pulmonary tuberculosis, arthritis, hydronephrosis with Dietl's crisis, migraine, pylorospasm, intercostal neuralgia, hypotension and angina pectoris. Graham (Roscoe R.), in discussing the failures of surgery in this class of gallbladder disease, noted three points: (1) irreparable damage from infection and scarring, (2) persistence

of gastric and pyloric spasm, and (3) failure to remove stones from the common duct.

Deaver and Bortz considered the most important differential lesion to be gastric or duodenal ulcer and carcinoma of the stomach. Kanuth stated that ulcer and spastic conditions of the gastrointestinal tract and diabetes mellitus may cause false positive reactions of the cholecystogram. Residual symptoms then, he noted, were due to errors in diagnosis, residual pathologic changes, physiological causes, duodenal diverticula, tubercular spondylitis and chronic gonorrheal peritonitis must be ruled out. Walters listed in addition that cholangeitis, pancreatitis, carcinoma of bile ducts, ampulla or pancreas, gastric crises and kidney lesions must be differentiated from the noncalculous cholecystitic syndome. The large number of differential lesions encountered in practice and by reading on the subject leaves one with only one thought, namely, that practically every diagnostic aid must be used in order to establish a working diagnosis if unnecessary surgery is to be avoided.

The points discussed in regard to etiologic factors cannot possibly be disregarded in the study of a patient with this dyspeptic syndrome.

SUMMARY

The etiology of chronic noncalculous cholecystitis is based on a multiplicity of related factors.

The three phases of the etiology are pathologic, mechanical and physiologic.

Differential diagnosis is perhaps one of the most important aspects of this syndrome.

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In cholecystitis there is usually no jaundice, but all the signs of local and general infection—pain, tenderness, leucocytosis, and fever—are present.

THE USE OF STILBESTROL IN THE MENOPAUSE AND OTHER CONDITIONS*

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DODDS, Lawson and Noble, Goldberg and Robinson, MacGregor, and Winterton and Loeser have brought to the fore a drug, identified chemically as 4, 4-dihydroxy-alpha-beta-diethyl stilbene. This substance, called stilbestrol, is capable of replacing in every way the action of estrone or estradiol, despite the fact that the molecular structure is entirely different from that of natural estrone. The amount of 1 mg. of diethylstilbestrol is equivalent to 25,000 international units of estrone, according to observers.

Noble demonstrated that administration of aqueous solutions of stilbestrol orally was followed by reduction of growth of the animals, with a dosage of 2 to 3 mg. Inhibition of the gonadotropic hormone of the anterior pituitary gland, with resulting atrophy of the gonads, was observed when larger amounts of stilbestrol were given. In lactating rats as low a dose as 2 to 3 mg. per day appreciably reduced the growth of their litters. That the mammary glands were in a condition to yield more milk was shown by their increased secretion when treatment was discontinued. It was not found possible to inhibit lactation completely, even when stilbestrol was administered to the female rat before parturition.

Mellish, Baer, and Macias reported that stilbestrol and stilbestrol dipropionate were at least as effective as an equal weight of estrone in producing growth and development of the immature rabbit uterus and in sensitizing it to progesterone. Subcutaneous implants of 10 mg. of stilbestrol and stilbestrol dipropionate in animals inhibited body growth and growth of the gonads. Treatment with the stilbene derivatives increased the weight of the pituitary, but did not cause a significant change in the weight of the adrenals.

It has been shown by Zondek and Sulman that approximately 50 per cent of the stilbestrol given is excreted, and can be recovered from the urine and feces, in approximately equal amounts. In contrast to estrone, stilbestrol is only rendered inactive in the organism to a small extent, resembling, in this respect, the hormone esters. Stilbestrol remains deposited at the site of injection for a considerable time (depot formation) and from there it is slowly absorbed, similar to the hormone esters. In the excreta large amounts of the active substance are found. The fact that the organism is unable to inactivate considerable amounts of stilbestrol may explain its possible toxic activity.

Kellar used stilbestrol in a group of over twenty women. In six patients suffering from severe menopausal symptoms, he was able to control the symptoms fully. In three cases of senile vaginitis and two of leucoplakia vulvae, the patients benefited to a marked degree. Three cases of secondary

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amenorrhea bleed after courses of stilbestrol, but biopsies revealed only a proliferative endometrium with numerous mitoses. Attempts at treatment of inertia type of labor and therapeutic abortion failed to reveal any conclusive results as to sensitization of the uterus or improvement of uterine contractions. Occasionally there was, however, a striking success. Inhibition of lactation was induced by administration of 3 mg. of stilbestrol daily for a few days. There were three cases of nausea in this series.

Shorr, Robinson and Papanicolaou treated forty-four patients with stilbestrol. In eight cases, full follicular vaginal smears were obtained, while in seventeen others advanced prefollicular smears were shown. However, there was failure of increasing doses of stilbestrol to bring about progressive changes in the smears. Bleeding after cessation of treatment occurred in several cases of menopause and amenorrhea. There was relief from symptoms of menopause in twenty-eight cases. Toxic manifestations occurred as follows: nausea in thirty-seven, vomiting in fourteen, abdominal distress in thirty-one, diarrhea in seven, lassitude in thirty-two, skin rashes in eight, psychotic reaction in one, vertigo in six, marked thirst in one and paresthesias in two. These toxic symptoms persisted in some instances as long as three weeks after cessation of the treatment. The concept of local irritation of the gastric and intestinal mucosa is contradicted by the large number of severe reactions encountered when the drug was given intramuscularly. Buxton and Engle reported improvement of symptoms in seventeen patients treated with stilbestrol. Nausea and vomiting occurred in four cases and bore no relationship to the amount of the drug used. One patient developed albuminuria and casts in the urine, whereas previously no such findings had been observed. Liver function tests were inconclusive. Winterton and MacGregor treated fifty-one patients with stilbestrol and obtained good results in treatment of menopause and amenorrhea, similar to those obtainable with estrogens. There were six patients who suffered by-effects, mostly nausea, with only two cases of actual sickness. Inhibition of lactation occurred in three patients with doses of 5 mg. daily in whom the drug was used before lactation had set in, and was of little advantage once lactation had begun.

Karnaky used stilbestrol in over one hundred patients, with gonorrheal vaginitis, pruritus vulvae and senila vaginitis. He gave doses up to 1 mg. without any harmful symptoms, but obtained nausea and vomiting with 1 mg. or over, occasionally. He states that he gave 5 to 90 mg. at one injection without ill effects. Vaginal pH changed from 6 to 7.2 to pH of 4.0 with 5 to 7 mg. of the parenteral medication. The patients were greatly benefited. Equal effects were obtained by mouth, by injection and by suppository. The vaginal mucosa became adult in type. Functional uterine bleeding was improved or stopped in fourteen cases. There was an improvement in the character of the endometrium on biopsy, the endometrial glands were smaller in some cases and the cystic endometrium returned to the resting stage. Three cases of amenorrhea were made to bleed by giving 2 mg. twice a week for three weeks. One case of dysmenorrhea was relieved.

Geist and Salmon used stilbestrol in thirty-eight menopause cases. When given by injection, estrogen smear changes appeared after administration of 10 to 20 mg. Flushes, in particular, were relieved by total dosages of from 15 to 25 mg. Nausea and anorexia occurred in 20 per cent of the women. In twelve patients who had oral administration, ten developed toxic symptoms on doses of 1 to 5 mg. daily. Only eight patients were able to continue the drug more than a week. It is interesting to note that two of the cases which did not respond clinically showed vaginal smears indicating an estrogen effect. Resnik's work with stilbestrol yielded good clinical results in most cases with about 25 per cent toxic by-effects noted.

Biship, Boycoll and Zuckerman noted nausea and vomiting in three of forty-six patients. Varangot found severe gastrointestinal reactions in eight of eighteen women. Ehrhardt, Kramson and Schafer also reported a large number of unpleasant side effects which, however, they incline to attribute to overdosage of stilbestrol. R. Kurzrok, Wilson, and Perloff reported a number of toxic symptoms resulting from the use of stilbestrol.

Lack of agreement is seen in the reports of toxicity studiesi n animals. They uniformly confirm the estrogenic activity of the compound and reveal an extraordinary similarity in action to the natural estrogens. But in contrast to the early indications of its harmlessness, Loeser noted in rats, decreased appetite, epistaxis, vaginal and intestinal hemorrhages, fatty degeneration with subsequent necrosis of the liver, enlargement of the adrenals with arterial hyperemia and bleeding and enlargement of the spleen with hemorrhagic reaction in the islands. According to Krietmair and Siechmann the administration of from 0.5 to 1 mg. per Gm. to mice resulted in death in from 10 to 16 days. In rats 1.5 to 5 mg. per Gm. resulted in paralysis and death in an hour. Tislowitz observed a disturbance of the hyelogenic system, and granulocytopenia and anemia in dogs receiving 5 mg. by injection for from twenty-five to fifty days. Morrell, on the other hand, has failed to observe any pathologic changes in the tissues of rats, rabbits and monkeys.

A series of 122 women treated by the administration of diethylstilbestrol and diethylstilbestrol dipropionate is herein reported. Since these two synthetically prepared compounds have shown much the same effects and benefits, as well as by-effects, and the effect on the vagina appears to be almost identical, we do not differentiate in the results obtained.

The indications for treatment were as follows: menopause, 112 cases; arthralgia (menopausal), eight cases; migraine, two cases; and premenstrual tension, four cases.

Administration of stilbestrol was by intramuscular injection in doses of 1 to 5 mg. twice weekly or parenterally in amounts of 2 to 3 mg. daily. Similar results were obtained with the two modes of therapy.

Vaginal pH determinations and vaginal smears were done routinely at weekly intervals during and after cessation of stilbestrol treatment. Cases previously treated with estrogens revealed a vaginal pH of 4 to 5 and a vaginal smear of plus 3 to 4, according to the technic of Papanicolaou and Shorr. Untreated patients usually showed a vaginal smear of plus 1 to 2, and an acidity of pH 6 to 7.

After administration of 1 mg. of stilbestrol, for a period of two to three weeks, the vaginal acidity ranged between pH 5 to 6 generally with a plus 2 to 3 vaginal smear. After administration of 2 to 5 mg. of stilbestrol for a period of two to three weeks, the vaginal acidity was between pH 4 to 5 with a plus 3 to 4 smear. A number of cases showed considerable inconsistency between the vaginal smear and pH determination, such as a full estrogenic smear with pH of 6 to 8. Five weeks after cessation of stilbestrol medication, the general picture was that of reversion to the untreated state. There were several exceptions, in which full follicular smears and pH of 4 to 5 were found. A number of these patients complained of moderate menopausal symptoms, even though full estrogenic vaginal effect was noted, a finding in accord with other reports.

Biopsies of the endometrium in cases of bleeding varied from hyperplasia during menorrhagia to insufficient material in a postradium menorrhagia, to a secretory endometrium in a thirty-seven year old woman with premenstrual tension and menopausal complaints.

Successful results were obtained in seventy-eight cases or 64 per cent, with dosage of 2 to 5 mg. administered by injection, biweekly, or 2 to 3 mg. given parenterally daily. A few patients were benefited by doses of 1 mg. daily. The two cases of

premenstrual migraine were aided. Five of the cases of arthralgia were improved. Four women with premenstrual tension were helped in various degree. There were twenty-eight cases, or 35 per cent, who were intolerant to stilbestrol and in whom medication had to be discontinued almost immediately. Total dosage in some instances was 200 mg. given over a period of two to three months.

Reactions to stilbestrol therapy occurred as follows:

	No. of Cases
Locate reaction to injection or generalized rash with pruritus	10
Nausea	37
Vomiting	20
Epigastric distress	10
Diarrhea	7
Weakness or faintness	4
Aching joints	1

Among the toxic by-effects, nausea usually lasted for two to three days and diarrhea for the same length of time. In no instance was there any tenderness over the liver or jaundice. Mastalgia did not occur. There was no bleeding in postsurgical menopause cases. Increased vaginal secretion occurred in several patients. Moderate bleeding occurred in thirteen cases, in women still menstruating with menopausal complaints during treatment with stilbestrol. Bleeding occurred in one patient six years postmenopause lasting fourteen days.

The effect of stilbestrol upon lactation will be reported at a later date.

SUMMARY

1. Stilbestrol was used in a series of 122 women mainly with menopausal complaints.

2. Vaginal smears generally showed a good estrogenic effect.

3. Vaginal pH determinations frequently did not coincide with the cytologic changes.

4. Successful results were obtained in 64 per cent of cases.

5. Toxic manifestations occurred in a considerable number of patients, the most frequent being nausea, which took place in thirty-seven cases, or 30 per cent.

6. Toxic manifestations did not seem to depend on total dosage.

7. Stilbestrol should be used *only* on direction of a physician and the patient followed carefully.

We wish to thank the Winthrop Chemical Company and the Endo Products Company for their co-operation in supplying the stilbestrol used in this series.

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DIVERTICULA OF THE STOMACH

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GASTROSCOPY is an increasingly valuable method of diagnosis. Numerous lesions involving the stomach are being visualized and accurately described by able gastroscopists. Gastric diverticulum is one of the less frequently seen lesions in any endoscopic clinic. Because of this, we should like to present certain features of these lesions and give the clinical records of two patients with this condition.

The differentiation between gastric diverticula and diverticulum-like formations occurring secondary to perforating peptic ulcers or carcinoma is at times difficult but extremely important.

INCIDENCE OF DIVERTICULA OF THE STOMACH

Martin could find no record of diverticula of the stomach in the archives of the history department of Johns Hopkins Hospital. He found five cases reported by the pathologic department. Shiflett found an incidence of 0.65 per cent during roentgenologic study of stomachs in 786 patients. Cheney and Newell found two gastric diverticula in 11,828 roentgenologic examinations of the stomach. Rivers, Stevens and Kirklin reported that four gastric diverticula were found in 3,662 routine necropsies, and ten diverticula were removed in 11,234 exploratory operations of the stomach at the Mayo Clinic.

CLASSIFICATION OF GASTRIC DIVERTICULA

Diverticula of the stomach have been classified as follows: (1) true (congenital) diverticula; (2) false (acquired) diverticula, (a) pulsion type and (b) traction type.

The congenital type of diverticula is believed to be the result of malformations or interrupted development during the embryonic period. All layers of the stomach wall are intact.

The false or acquired type has one or more layers of the stomach wall absent. It is believed that some abnormal force is responsible for the pouching. This group has been divided into the pulsion and the traction types. In the former group, the implication is that the force which caused the diverticulum has come from within the stomach. Many theoretical causes have been given for increasing intragastric pressure with subsequent herniation of part of the gastric wall and formation of a diverticulum. Labor, pyloric obstruction, vomiting, chronic cough, foreign bodies in the stomach and constipation with straining at stool are some of the possible etiologic factors mentioned in the literature.

Traction diverticula result from contraction of perigastric adhesions. Any organ which has been the site of an inflammatory process or of a previous surgical procedure may be responsible for perigastric adhesions. As these adhesions contract, they may cause formation of a diverticulum in the stomach. The gallbladder, pancreas or spleen may be the primary organ involved. Adhesions between the anterior abdominal wall and the stomach may also be responsible for this type of diverticulum. Most diverticula occur near the cardia on the posterior wall toward the lesser curvature, but they may occur at any site. Pancreatic tissue and benign growths, such as adenomas and myomas, have been described in gastric diverticula.

Formation of an acquired false diverticulum in the stomach may be the result of a perforating ulcer or a neoplasm.

GASTROSCOPIC FINDINGS

Gastroscopic examination should aid in differentiating these last named lesions and

gastric diverticula. The orifice of a diverticulum has the appearance of a circular hole. The margins are rounded and sharply defined. The surrounding mucosa may be entirely normal. There is no sign of infiltration at any point. A penetrating gastric ulcer usually has a base which is covered with a gray or white exudate, or is more rarely covered with blood. The surrounding mucous membrane is quite apt to show evidence of an associated inflammatory reaction. A penetrating carcinoma shows signs of ulceration in the base of the sac, and the surrounding margins are irregular and infiltrated.

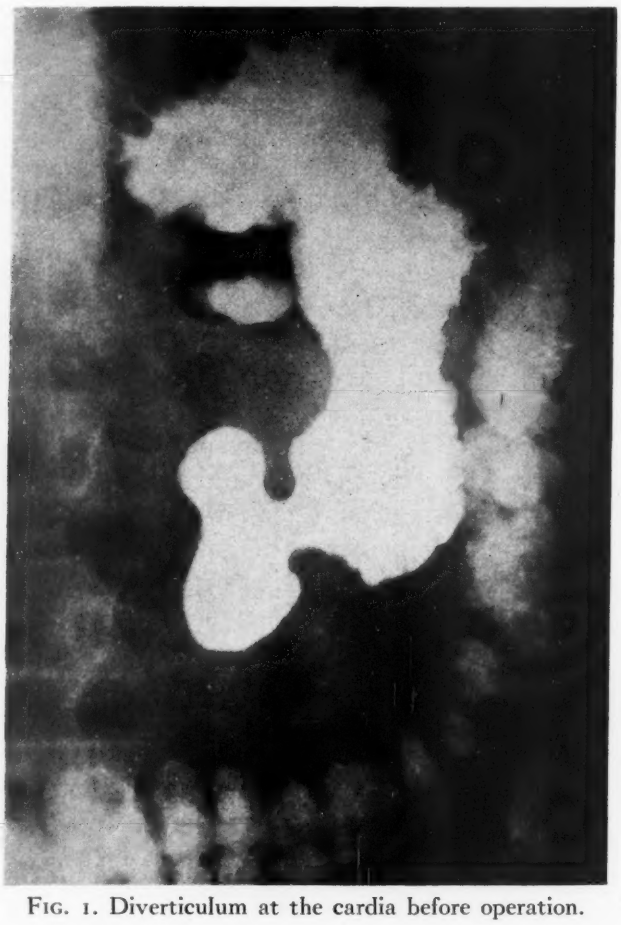


FIG. 1. Diverticulum at the cardia before operation.

SYMPTOMS

It is thought that most gastric diverticula do not give symptoms. In certain cases, however, there are definite symptoms present which disappear after excision of the diverticulum. These may range from a dull sense of discomfort or a sense of pressure in the epigastrium to a definite epigastric pain. This pain may be periodic, burning or gnawing in character, and may or may not be relieved by food. At times, the pain may radiate to the lower retrosternal region. Massive hematemesis has been described.

CASE REPORTS

CASE 1. The patient was a man, thirty-seven years of age. For the last twelve years he had experienced "pressure pains" in the upper part of the abdomen. He stated that he would usually awaken about seven A.M. with a "bloated sensation" in the upper half of the abdomen. He would experience an urgent desire to pass flatus. Belching and passage of flatus would relieve the distress. There would be considerable discomfort again about four or five hours after eating. The trouble seemed to be definitely worse in the decubitus position, and for the past two years he had experienced

daily nocturnal distress in the upper part of the abdomen. Almost every night he would take soda water by mouth and induce vomiting, which would give relief. The vomitus at times would contain particles of food eaten twelve hours previously. His father-in-law, a physician, had taken a roentgenogram of his stomach and found a gastric diverticulum.

He was referred to the Mayo Clinic. Roentgenologic study revealed a diverticulum in the upper part of the stomach near the cardia. (Fig. 1.) Gastroscopic examination was performed and it was possible to obtain an excellent view of the orifice of the diverticulum which was located high on the posterior wall. The opening appeared as a sharply circumscribed hole and was about the diameter of a small finger. There was a mild degree of gastritis in the lower quadrant of the orifice of the diverticulum, but there was no evidence of infiltration or ulceration. (Fig. 2.)

The diverticulum was explored surgically and was found to arise from the posterior wall of the cardiac end of the stomach. The orifice was 2.5 cm. from the lower end of the esophagus. The diverticulum was 3.5 to 4 cm. in diameter, and its orifice was about 1 cm. in diameter. It was excised, and the resulting defect in the gastric wall was sutured. The patient made a very good recovery. Subsequent information after his return home states that he is getting along very well. He is able to sleep through the night without any discomfort. His appetite is good and he has gained 10 pounds (4.5 kg.).

Case II. This patient was a woman, thirty-three years old. She had been under observation and treatment at the clinic for six years. At the time of her first admission, in 1932, she told of being troubled with flatulence, bloating and rumbling in the abdomen. At times, she would have frequent soft stools, passing between two and four stools in twenty-four hours. Roentgenologic studies of the stomach revealed a diverticulum of the cardiac end of the stomach. Roentgenologic studies of the gallbladder, colon and small bowel gave negative results. Diagnoses of irritable bowel and diverticulum of the stomach were made. It was believed that her symptoms were coming from her irritable bowel, and she was given a dietary regimen. It was not thought advisable to explore the gastric diverticulum at that time.

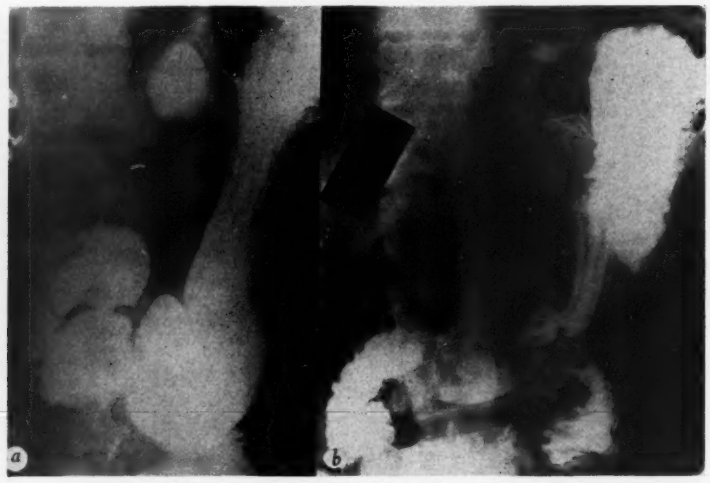
She returned to the clinic in July, 1938, at which time she stated that during the past year she had experienced a periodic, gnawing, epigastric pain. The last attack of pain had occurred four months before coming to the clinic. The pain would come about two hours after meals and was occasionally associated with nausea and vomiting. On one occasion she had vomited bloody material. The pain would persist until she would eat, or drink a glass of milk. During an attack, pain would be present every day and would occasionally occur at night. Gastroscopy was performed elsewhere during her last attack of distress, and two or three superficial erosions were seen in the region of the diverticulum. Alakalis and tincture of belladonna were prescribed.

Fig. 2. Gastroscopic appearance of diverticulum.

On her last admission at the clinic the roentgenologic examination again showed the diverticulum at the cardiac end of the stomach. (Fig. 3A.) Gastroscopic examination was performed and the orifice of the diverticulum was seen just below the cardia. There was no evidence of inflammation of the gastric mucous membrane in the neighborhood of the diverticulum. The orifice was seen to open and close in a rhythmic fashion. It was believed that the symptoms referable to the epigastrium might be coming from the gastric diverticulum. Exploration of the diverticulum was advised.

The stomach was explored and a false diverticulum was found along the lesser curvature just below the cardio-esophageal orifice. The diverticulum measured about 3.5 cm. in diameter. The anterior wall of the stomach was

opened and the mouth of the diverticulum was found to be wide open. It was decided that the sac could not be excised without considerable risk because of its high location. Because of this, it seemed advisable to invert the diverticulum. The patient's convalescence was uneventful. Roentgenologic examination after operation showed no evidence of the diverticulum. (Fig. 3B.)



A B

FIG. 3A. Diverticulum at the cardia before operation; B, roentgenogram of stomach after operation.

A report by letter one year after operation states that she is "generally speaking, well, and losing no time from work." She occasionally experiences distress from her irritable bowel condition.

SUMMARY

Gastroscopic examination can aid in differentiating gastric diverticula from diverticulum-like formations which develop secondary to perforating peptic ulcers and ulcerating carcinomas of the stomach.

A case of true diverticulum and a case of false diverticulum of the stomach are presented. Both patients had symptoms which were thought to be due to the diverticula. These symptoms disappeared after surgical procedures which eliminated the diverticula.

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BURSA AND GANGLION

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SINCE 1780, when Monro published "A description of all the bursae mucosae of the human body," bursae have been the subject of considerable study and speculative comment among medical writers. Even down to the present time the subject has remained of interest because of the recognized relationship between the joints proper and the bursae. It is now generally conceded that, from anatomic, physiologic and pathologic viewpoints, there exists more than an academic relationship between them. Some authors go so far as to consider the joints proper as merely highly differentiated bursae. According to Piersol's broad definition, bursae are sacs filled with fluid which are found wherever friction may occur between various structures. In addition to the constant and acquired bursae, this definition would apply to the joints and also to the pleural, peritoneal and pericardial cavities. For practical purposes, this definition is perhaps too wide in its scope and we must necessarily restrict this portion of our report to include only the bursae. We must admit, however, that very little play on the imagination is required in order to place the joints in the same general category with the bursae.

Along these same lines, the subject of the tendon-ganglion also must be considered. In this, we are treading on firmer ground, and therefore can feel justified in considering bursae and ganglions together in the same discourse. According to H. T. Jones, "bursal hygromas, including the accidental or occupational bursae, such as those on clubfeet and miners elbows, together with carpal ganglions and the synovial lesions of the fingers, are variations of the same fundamental process." For the sake of simplicity, however, we shall consider them under separate headings. A correlation between the two will be made when pertinent.

BURSA

Henle,[25] in 1838, considered the linings of the joints and bursae as epithelium. Later, Heuter, Hagen-Torn, Hammar, and others have declared the synovial cells to be of connective tissue origin, as indicated by Virchow. This is the viewpoint generally held by many today, although Kling,[32,33] Meyeda, and King, among recent authors, look on the synovial cells as truly secretory in nature, and therefore either epithelial or very highly differentiated connective tissue closely akin to epithelial elements. Kling, in expressing his opinion as to their secretory nature, based it on a study of the synovial cells which he has made by means of an original staining technic. He claimed to have demonstrated mucin vacuoles in the cytoplasm of these cells, just as one may observe them in the secretory epithelial cells of the intestinal tract. By means of two other methods of staining (Mayers and Galantha), we[4] have been unable so far to demonstrate such secretory granules either in the normal or in the pathologic synovial membranes. As yet, we have not employed Kling's method of staining.

Dömény, in 1897, reported his work on the embryology of the deep and superficial bursae in the human embryo. He concluded that the deep bursae developed before the superficial ones, but that the process of development was essentially the same in each instance. The superficial bursae often did not reach their anatomic maturity until long after birth and after movement had been initiated.

According to Jones, the development of the deep bursae is very closely related to development of the joints. Like Piersol, he considered the joints as highly differentiated and specialized bursae.

In 1890, Schuchardt described a bursal hygroma which he had removed from the external malleolus of a tailor. He described the phenomenon of cystic bursal formation as a "process of inflammatory production of new tissue" with hyperplasia of connective tissue and later liquefaction. He was able to demonstrate mitotic figures in the proliferating cells.

Langemark, in 1903, held that this so-called proliferation of connective tissue did not take place before liquefaction in bursal hygromas. He believed that the liquefied material was a purely degenerative substance, a viewpoint which fits well with the conception held by many that the mucinous substances present in the joint and bursal fluids are the products of degeneration rather than true secretion. Langemark further thought that bursae are often likely to become enlarged and filled with fluid as a result of repeated trauma. The enlargement was regarded by him as simply an exaggeration of the process which originated the bursae.

Codman, in 1906, first described subacromial or subdeltoid bursitis. At that time he recommended surgical removal of the bursa and whatever deposits might have formed in or about it.

It was Churchman, in 1909, who called attention to specific infections in bursal swellings, particularly syphilis. He reviewed twenty-eight cases of bursitis which he considered the result of syphilis. He mentioned the rapid response to specific therapy in these cases. In respect to specific diseases of the bursae, Earl, in 1918, pointed out that gonorrhea, tuberculosis, syphilis and metabolic disturbances such as gout, may affect the bursae. He also mentioned that bursitis may follow pyemia, typhus, scarlet fever and variola.

Henderson in discussing Earl's paper recalled that in prepatellar bursitis repeated bacteriologic studies in his experience had not shown the presence of organisms and that he was inclined to believe that in the majority of cases of bursitis, particularly prepatellar bursitis, mechanical irritation was the principal etiologic factor.

Perhaps one of the most enlightening works on the subject of the bursae within recent years is that of H. T. Jones. In 1930, in addition to reporting fifty-five cases of cystic bursal hygromas from clinical and pathologic standpoints, he made a rather comprehensive review of the literature on the general subject of bursae. He touched particularly on the historic conceptions of their development and the anatomic and embryologic backgrounds for such conceptions. We have drawn freely from his references as a background for this study.

It has been known for some time, as indicated by Earl, in 1918, that tuberculosis may infect the bursae. Among recent reports, those of Cicala, Meyerding and Mroz, and Deacon are of interest. Meyerding and Mroz, in 1933, emphasized the importance of tubercular lesions in the femoral trochanters and associated bursae, while Cicala, two years later, reported four cases of this disease involving the bursae in this region. Deacon, in 1935, reported a case of tuberculosis involving the subdeltoid bursa bilaterally.

Gonorrhea may produce a bursitis secondary to the primary inflammation in the genital tract. Strominger, in 1936, has given the latest report of this condition, indicating the serous nature of the fluid usually found in this type of bursitis.

Among other specific infections fungi have been known to invade the bursae, but only rarely.

Neoplasms of the bursae, if one does not include the cystic hygromas which, from all prevailing evidence, do not appear to be true neoplasms, are reported as being extremely rare. Geschickter and Lewis, in 1934, were able to collect only thirty reported cases from the literature and from the records of the Johns Hopkins Hospi-

tal. Among the most common tumors were benign and malignant chondromatous growths and fibrosarcomas. They found the prepatellar bursa the one most often involved. It was shown that osteochondromas were likely to recur and become malignant. Zwahlen has reported the development of synoviomas from the bursae as well as from the tendon sheaths. Xanthomas also have been noted to arise from the bursae. It is conceivable that the bursae may give rise to any type of neoplasm which might develop from connective tissue. In respect to the opinion held by some that the synovial cells are epithelial in nature, it is to be noted that true epithelial bursal tumors are conspicuous by their absence in the literature. The synoviomas, according to McDonald, appear to resemble the endotheliomas more than any other tumor, an observation which in part substantiates the opinion that all cellular elements found in bursae originate from connective tissue.

Anatomic Classification. Piersol has classified all bursae into two main anatomic classes: the deep and the superficial bursae. He refers to the deep bursae as "synovial" and to the superficial as "mucous," indicating that there is, in his opinion, a difference in the lining membranes of the two types. It is our contention that there is no essential difference between the lining cells of the deep bursae and those of the superficial ones. The subsynovial tissue may be thicker in the deeper ones, but the structure throughout and the derivation are essentially the same, that is, all bursae arise from the mesoderm. Therefore, we believe that the separate terms, "synovial" and "mucous," are obsolete and that the term, "synovial," should apply to all bursal lining membranes, including those of ganglions.

Of the deep bursae (Piersol's "synovial" group), those that have a connection with a joint may be normally present, or may be a congenital addition; those that do not have a connection with a joint may be normally present, a congenital addition or of the adventitious or acquired type.

Of the superficial bursae (Piersol's "mucous" group), those that have a connection with a joint (socalled synovial cysts) may be of the congenital or acquired type; those that do not have a connection with a joint may be normally present, a congenital addition or of the adventitious or acquired type. The types of bursae that are of great clinical importance are the deep bursae that are normally present, and the superficial bursae that are normally present or are of the adventitious or acquired type.

It is not our claim that such origins always may be demonstrated or that the classification holds strictly true to form in all instances. It seems that, at some time during the development of certain bursae which normally do not connect with joints, there might have been such a connection. Cords of fibrous tissue which occasionally are seen connecting a synovial cyst or a ganglion with the capsule of a joint are, perhaps, remnants of such connections.

Etiologic Classification. Meyerding[40,41] has said that "Bursitis may be classified as acute or chronic, traumatic or infectious, and syphilitic, gouty or malignant." He has also mentioned tuberculosis, gonorrhea and rheumatism as etiologic factors. He has further observed that "when bursae become distended, they are called bursal cysts or hygromas." Shands included more or less the same factors and agents in his discussion on the subject. He has emphasized that trauma is by far the most important, although he acknowledged that even as rare a condition as a toxic bursitis from lead poisoning had been known to exist. Shands did not refer to cystic bursal hygromas or neoplasms.

For our own purposes of clarification, we have outlined a detailed etiologic classification of bursitis and hygromas, as may be seen in Table 1. We have based this on those descriptions which have been mentioned and on whatever information we could gather on the subject from the current literature.

In regard to the acute types, the outline is self explanatory. Under nonspecific infec-

tious bursitis, we have included rheumatic as well as toxic and unknown types, because prevailing knowledge does not allow us more specific terms. It is known that in certain types of arthritis and rheumatoid conditions one may observe a bursitis which has all the characteristics of an acute infectious process but from which a specific agent of disease cannot be cultivated. One also may observe the same condition after certain generalized infectious diseases.

TABLE I

ETIOLOGIC CLASSIFICATION OF BURSITIS AND HYGROMAS

I. Acute
- *A.* Infectious
  - 1. Specific
    - a. Pyogenic (staphylococcic, streptococcic, pneumococcic)
      - 1. Suppurative
      - 2. Nonsuppurative
    - b. Gonococcal
  - 2. Nonspecific
    - a. Rheumatic
    - b. Unknown
- *B.* Traumatic
- *C.* Traumatic and infectious

II. Chronic
- *A.* Infectious
  - 1. Specific
    - a. Pyogenic
    - b. Gonococcal
    - c. Tubercular
    - d. Syphilitic
    - e. Fungous infections
    - f. Others
  - 2. Nonspecific
- *B.* Traumatic
- *C.* Traumatic and infectious
- *D.* Metabolic
  - 1. Gouty
  - 2. Calcinosis circumscripta
- *E.* Cystic manifestations
  - 1. Cystic bursal hygromas
  - 2. Ganglia
- *F.* Neoplastic
- *G.* Congenital anomalies and hereditary tendencies
- *H.* Toxic reactions to metal and other specific poisonings

In the chronic type of bursitis, by far the most common is the traumatic. In both the acute and the chronic traumatic types there may occur superimposed infection. The term, "traumatic," is meant to include any type of trauma whether it is acute or chronic irritation.

We recognize readily the weak points in this classification. For instance, calcinosis circumscripta has been included under the metabolic type of bursitis even though we are not sure that it is a metabolic disease. It is known to have hereditary tendencies and it may affect siblings, as illustrated in a case to be reported by one of us.[18] With reservations, we have placed cystic bursal hygromas and the ganglia in the same class. Our reasons for so doing will be found in the section on "Ganglion."

It is admitted that it would be a difficult feat to classify all bursal swellings in so detailed a fashion as we have indicated. In our own cases we have found this true. However, there is no reason why such cannot be attempted, if a reasonable amount of judgment is exercised. Perhaps future efforts toward more painstaking diagnosis in these cases will prove helpful in amending or correcting our present attempt to classify them.

Clinical Material. In this report we are including thirty-seven cases of bursitis which were encountered over a period of six years, from January, 1928 to December, 1934, at the Mayo Clinic. A summary of the pathologic studies made in these cases had been previously reported.[16] In these thirty-seven cases a total of forty-one bursae were removed surgically. This series of cases does not include the acute suppurative types nor does it include those cases of bursitis in which treatment was conservative. In addition, the bursae which have been removed from bunions and the so-called bursal cystic hygromas were not included, with the exception that in the latter case there might have been borderline pathologic types included under the chronic traumatic cases in which distinctions were made with difficulty.

There were twenty-six males and eleven females in this series; the average age was forty-five years. The youngest patient was fifteen years of age, the oldest, sixty-six. The average duration of symptoms was two and one-half years, the longest, fifteen years and the shortest, twenty-four hours.

The anatomic distribution of the bursae was as follows: elbow, five; olecranon,

seventeen; wrist, one; finger, one; prepatellar, twelve; popliteal, one; head of tibia, one; shoulder, one; subacromial, one, and foot, one.

Data that pertain to the types of surgical procedures and results are given in Table II. The different types of disease and the results of treatment in each type are indicated in Table III.

TABLE II
SURGICAL PROCEDURES AND RESULTS

Type of Procedure	Good Result	Recurrence	Results Unknown	Not Excised	Miscellaneous
Complete excision of sac	22	8	8		
Partial excision of sac	..	..	1	..	1*
Biopsy	..	..	..	1	
Total	22	8	9	1	1

* Persistence of disability without recurrence of swelling.

Comment. It will be noted that in only one case of subacromial or subdeltoid bursitis was operation necessary during the period of time mentioned. When Codman originally described the condition, he recommended removal as the indicated treatment in the chronic cases associated with calcification. We have observed that, if the proper conservative regimen is followed in these cases of the chronic type, there usually will be a gradual improvement in the symptoms, and often the deposits of calcium in or about the bursa will be absorbed in time. Diathermic induction has proved useful in the temporary relief of pain. In the acute cases with severe pain, one may resort to the injection of procaine, continuous traction and sometimes, roentgen therapy. With the exception of the subdeltoid bursa, surgical excision is undoubtedly the treatment of choice for chronic and persistent bursitis associated with swelling and symptomatic discomfort and disability. This is especially so in those cases in which the affection is local and unilateral and in which the bursa is readily accessible for operation.

TABLE III
RESULTS OF TREATMENT IN RESPECT TO DISEASE PRESENT

Types of Disease	Number	Good Result	Recurrence	Unknown	Miscellaneous
Chronic traumatic	18	12	2	3	1*
Acute traumatic	4	3	1		
Chronic infections					
Rheumatic	1	1			
Others	5	2	3		
Tuberculosis	3	1	2		
Gouty	2	..	..	2	
Traumatic and infectious	2?	2			
Questionable	5	..	..	4	1—biopsy
Xanthoma	1	1			
Total	41	22	8	9	2

* Persistence of disability without recurrence of swelling.

In the forty-one cases in which bursae were removed there were only eight known recurrences. Every attempt should be made to excise the sac completely at the first operation. In the two cases in which it was known that only partial excision was performed, the results were disappointing in each instance. In the eight known cases of recurrence, there were undoubtedly some in which the sac was incompletely removed, even though the surgeon at the time of the operation believed that complete excision had been performed.

The most common types of acute and chronic bursitis were those caused by trauma. There were two other cases in which a history of trauma was obtained and additional signs and symptoms of a superimposed infectious process were present. There were no records to indicate that specific organisms had been recovered from these bursae.

We have included six cases under the chronic nonspecific infectious types. Two cases of multiple bursal swellings were included in this class, and the clinical indications were that they were the result of some infectious process. In the six cases

thus classified, rheumatic complaints were predominant.

Tuberculosis was the only specific infectious disease represented in the entire series. In two cases the bursae of the olecranon were involved and in one, those of the knee. In the latter case an arthrodesis was performed. A good result was obtained from the excision of one bursa of the olecranon whereas draining sinuses from the other bursa were present at the time of the last report. In all three cases there was no evidence of active pulmonary tuberculosis, and this is not unusual. In the case which Deacon reported with bilateral involvement of the subdeltoid bursa, there was no active disease of the lungs. In the majority of other cases of bursal tuberculosis reviewed in the literature, the same held true. Tuberculosis usually affects the large bursae around the large joints, such as the knee, hip and elbow. However, one of us (R. K. G.) recently operated upon a patient and found a tuberculous bursa at the base of the great toe without signs or symptoms of the disease elsewhere in the body. To our knowledge this is the only case which has been recorded in which tuberculosis was found to have infected a bursa about the toes.

We have included a case of xanthoma in a bursa. We did this assuming that a xanthoma is probably not a true neoplasm but rather a special reaction to inflammation often associated with a disturbance in the metabolism of cholesterol. At least this is the opinion held by Galloway and Broders and Ghormley, who have collected and studied the largest series of cases of xanthoma yet recorded. Geschickter and Lewis previously have observed the occurrence of bursal xanthomas. One might be justified in classifying a bursal xanthoma with gout as metabolic bursitis.

Although we have not included any cases of acute suppurative bursitis in this series, it might be well to mention their treatment. Usually they should be handled as any other acute suppurative infection, with rest, local heat and supportive treatment. Incision and drainage should be carried out as indicated, and special caution should be exercised that only the infected bursa, and not the adjacent joint, be drained. Meyerding[40,41] recalled a case of acute suppurative prepatellar bursitis in which the surgeon, unaware that the infection was localized in the bursa only, incised the knee joint proper, resulting in the expected pyarthrosis and subsequent ankylosis.

In infections resulting from streptococci, pneumococci, gonococci and sometimes staphylococci, some form of sulfanilamide should be administered if not contraindicated. Recently we have observed a case of pneumococcal bursitis of the shoulder following pneumonia in which a favorable response to drainage and oral administration of sulfapyridine occurred.

In the cases of acute traumatic bursitis, in which intense swelling is present, single or repeated aspirations may be resorted to in an effort to relieve the tension. Aspiration also may be employed for the acute infectious types of bursitis, for purposes of diagnosis and treatment in those cases in which the fluid is serous rather than purulent.

GANGLION

Carp and Stout have defined a ganglion as "a cystic swelling usually occurring in close proximity to joints and tendon sheaths and containing a thick mucinous fluid." Because of their proximity to tendon sheaths, ganglions are referred to often as tendon ganglions. The close relationship between cystic bursal hygromas and ganglions already has been alluded to. It is generally conceded that the lining of the bursae, joints and the ganglions is essentially the same type of tissue, although in the case of the bursae and joints, the synovial cells are commonly of a more highly differentiated character. Despite these similarities, there remains at least one important distinction which makes it difficult to consider the ganglion as a true type of bursa, at least, without some reservation. The bursa usually is found to have some

definite function either as a protector of a bony prominence or as a condenser of friction between gliding structures, even the pathologic and adventitious types of bursae while, the ganglion seems to have been donated to us by nature as an effect without a known cause. It is perhaps for that reason that so many writers have considered the ganglion a type of neoplasm. Then, in addition, with the exception of tuberculosis and nonspecific inflammation, ganglions are not, as a rule, so frequently victims of disease as are bursae. The explanation which has been offered for this is that the ganglions are, in themselves, a type of inflammatory reaction and are not to be considered as structures normally susceptible to the various diseases.

In reviewing the literature, one is impressed with the divergences of opinion in regard to the origin of the ganglion. Despite this inconclusive status, and perhaps for that very reason, the hypotheses regarding pathogenesis naturally claim our interest.

Eller, in 1746, advanced the hypothesis that ganglions resulted from rupture of the tendon sheaths. Later Vogt suggested their origin from the joints and bursae, as well as from the tendon sheaths.

Gosselin, in 1852, believed ganglions to be retention cysts arising in crypts of the synovial membranes. Virchow thought that ganglions developed from connective tissue clefts.

Henle,[24] in 1847, was perhaps the first writer to refer to ganglions as neoplasms. Meckel, in 1856, Hoeftman, in 1876, and Floderus, in 1915, advocated this same viewpoint. "Mucinous tumors," "serous cysts," "synovial dermoids" and "arthromas" are some of the neoplastic terms which have been affixed to ganglions.

Both Billroth and Volkmann, in 1882, considered the possibility of ganglions arising as herniations of tendon sheaths or of joint capsules.

The most generally accepted concept as to the origin of ganglions is the one originally proposed by Ledderhose, in 1893. He believed them to be degenerative cysts resulting from a cystic degeneration of the connective tissue around, but not inside, the joints. Among authors who have adhered to this concept are Thorn, Payr, Franz, Borchardt, Hofmann, Ritschl, Clarke, Thomson and Carp and Stout. Carp and Stout stated, in 1928, that ganglions were the result of a mucinous degeneration of the connective tissue, in which embryonic cysts originally were present.

Rees Jensen, in 1937, held that ganglions developed from embryologic rests in the periarticular connective tissue, basing his observations on the previous work of Harrison. Harrison, in studying the embryologic origin of derivatives of connective tissue, described the formation of synovial membranes, tendons and tendon sheaths from neophytic fibrils which had been elaborated by the gelatinous ground substance of the mesothelium. Jensen held that arrests in this development left potential pockets from which ganglions often developed.

It has been difficult, in the opinion of most authorities, to ascertain just how important a rôle trauma plays as an etiologic factor. Kuettner found a definite history of trauma in 20 per cent of his cases, but this certainly is not an amazing percentage when one considers how often the hands and wrists are subjected to trauma without the occurrence of ganglions.

Along with differences of opinion as to the genesis of the ganglion, we also have noted certain disagreements as to the best method of treatment. The oldest method consisted simply in bursting the ganglion by means of a book or a heavy object, dealing the swelling a sudden, swift blow. Then, of course, since the advent of aseptic surgical technic, surgical excision has been offered and frequently employed. Among conservative methods of treatment, aspiration with injection of sclerosing solutions, such as iodine or carbolic acid, into the sac frequently has been used. In respect to an ultraconservative attitude in the treatment of this condition, it is interesting to note that Carp and Stout, in their follow-up studies on twelve cases in which no treat-

ment whatsoever had been received found that seven, or 58 per cent, of the ganglions disappeared spontaneously.

Some surgeons have used a continuous pressure bandage over the area of the ganglion as a sole means of treatment, especially in those cases in which the patients have refused to have more radical procedures performed. The pressure bandage also has been used profitably as an adjunct to other forms of therapy. Neumüller and Orator in reporting 702 cases of ganglion, indicated that in ten cases in which a pressure bandage was used without other measures, the ganglion had disappeared and to their knowledge had not recurred. In the analysis of their results from all forms of therapy, they found that of fifty-two ganglions treated by bursting, twenty-three recurred. Of thirty-one cases in which the ganglion was surgically excised, in only one was there recurrence.

Kuettner in reporting the late results of treatment in 170 cases, recorded the following incidence of recurrences after the various types of treatment as outlined: puncture and injection, 57 per cent; breaking or bursting, 50 per cent; subcutaneous incision, 36 per cent and excision, 30 per cent.

Carp and Stout maintained that the method of injection and aspiration was the treatment of choice. We are outlining the analysis of their results in detail in order to evaluate properly their recommendation. (Table IV.)

Of 255 cases, Carp and Stout recorded follow-up studies on seventy and it is on these, or less than a third of their total cases, that they admittedly have based their conclusions as to the best therapeutic procedure. When it is considered that the authors have allowed the results of treatment in only eight cases out of this number (only eight patients were treated by aspiration and injection) to influence their preference in the treatment of the majority of all cases, their conclusions, in our opinion, do not appear to be entirely justified. Also, on analyzing the results in their cases in which treatment was by bursting or breaking, it is found that the percentage of disappearance is higher than in the procedure which they recommended, in approximately the same number of cases. Rees Jensen, in considering the pros and cons as to the choice of treatment of this condition, held that of all the procedures, complete surgical excision of the sac was the surest and safest.

TABLE IV
TREATMENT IN 255 CASES (CARP AND STOUT)

Method of Treatment	Total Cases	Cases Traced (Total —70)	Recurrence	Disappearance	Lesion Still Present
Operative excision	109	35	11 (31%)	24 (64%)	
None	81	12	.....	7 (58%)	5 (42%)
Breaking	32	9	2 (22%)	7 (78%)	
Aspiration, injection and pressure	16	8	2 (25%)	6 (75%)	
Strapping and pressure	7	3	.....	.....	3 (100%)
Baking and massage	5	1	.....	.....	1 (100%)
Aspiration and pressure	3	2	2 (100%)		
Roentgen rays	2				

Clinical Material. As in the series of cases of bursae, this collection of 102 cases of ganglion comprises the number encountered over a period of six years at the Mayo Clinic from 1928 to 1934. The pathologic findings also have been previously reported elsewhere.[16]

In the 102 cases, 104 ganglions were treated, because in each of two cases, two ganglions were present. A total of 115 therapeutic procedures were carried out on the 104 lesions. The larger number of procedures is, of course, due to the fact that a few of the patients returned for further treatment. The predominance of female over male patients is consistent with the reports of other authors as there were seventy-seven females and twenty-five males in our series. The average age of the patients of this series was 31.7 years, the oldest was aged sixty-four years; the youngest, eleven years. The average age at which the onset of symptoms occurred in this series was 28.7 years, as compared with an average of twenty-six years reported by Carp and Stout. The youngest patient was

four years of age, the oldest, sixty-four, at the time of onset. The average duration of symptoms was three years; the longest was twenty-five years and the shortest, ten days. Table v indicates the distribution of the lesions according to site. In addition,

TABLE V
ANATOMIC DISTRIBUTION OF LESIONS

Site of Lesion		Aspect			Total
		Dorsal	Palmar	Unspecified	
Hand	Right	3	2	1	6
	Left	4	1	1	6
Wrist	Right	20	6	6	32
	Left	26	8	7	41
Both wrists		..	..	..	1

seven ganglions occurred on fingers of the right hand, seven on fingers of the left hand, and in three instances, the respective hand involved was not specified.

In Table vi the results of treatment are given in detail. It will be noted that in by far the majority of our cases, surgical procedures were performed. The two recorded deaths occurred some time after the patients had returned home and were in no way the result of or connected with the presence of ganglion and the instituted treatment.

Comment. We are in agreement with Carp and Stout that the reason better results were not obtained by surgical excision is that the sac had not been dissected out completely in the majority of cases so treated. This is especially true of multilocular lesions and lesions that appear to be associated with inflammation. Surgical exploration and excision would appear definitely to be indicated in those cases in which one is uncertain as to the underlying pathologic condition. Many ganglions may be found to have a definite connection with a neighboring joint cavity. To our knowledge, no satisfactory means has yet been

TABLE VI
RESULTS OF TREATMENT IN 102 CASES, REPRESENTING 104 GANGLIONS IN THE TREATMENT OF WHICH 115 PROCEDURES WERE REQUIRED

Procedure	Ganglions Treated	Cases Traced	Results					Deaths Unrelated to Condition or Treatment
			Good		Recurrence		Unknown	
			Number	Per Cent	Number	Per Cent	Number	
Partial excision	2	0	..	.....	..	....	2	
Complete excision	97	57	37	61.4	20	38.6	38	2
Excision and injection of 2 per cent formalin into wound	3	3	1	33.3	2	66.7		
Excision and injection of iodine into wound	1	1	1	100.0				
Total excisions	103	61	39	63.9	22	36.1	40	2
Incision and introduction of iodine	1	0	..	.....	..	....	1	
Breaking	4	4	1	25.0	3	75.0		
Aspiration and injection of iodine	6	6	2	33.3	4	66.7		
Aspiration and injection of iodoform	1	0	..	.....	..	....	1	
Total aspirations	7	6	2	33.3	4	66.7	1	
Grand totals	115	71	42	59.2	29	41.0	42	2

devised by which this connection may be diagnosed preoperatively.

The use of iodized oil and, in some instances, air has been resorted to in demonstrating connections between the joints and other structures such as bursae and ganglions. Because of the irritating properties of the oil and the poor contrast obtained with air, neither agent has been of much value in solving this particular diagnostic problem. However, in this connection, Dr. H. L. Day drew our attention to the work reported, in 1938, by Titus, Tafel, McClellan and Measer. After numerous clinical and experimental studies, these investigators recommended the use of a preparation composed of skiodan (40 per cent) and acacia (20 per cent) in uterosalpingography. They found this preparation to be nonirritating, quickly absorbed and rapidly excreted in the urine. Possibly this same preparation could be used in studying the connections between joints and associated ganglions or bursae. We believe this worth a trial, certainly in the experimental laboratory; if such experience were successful, clinical use of the method may be warranted.

There are other reasons, such as the presence of deformity, interference with function and cosmetic effect, which should influence the surgeon to recommend operation. When one has set apart from a series all cases that are amenable to operation, the remaining cases, most suited to other forms of treatment are comparatively few.

The method of aspiration and injection of sclerosing solutions offers certain advantages but its limitations must be realized. It is applicable only to ganglions that are definitely situated in easily approachable regions, such as the dorsum of the wrist. Repeated aspirations and injections are usually necessary because a single treatment rarely produces a cure. In fact, failure is almost certain to follow a single treatment. The procedure has the advantage of not leaving a scar. In a limited number of carefully selected cases we believe that it is a useful method.

The employment of general anesthesia with a tourniquet placed on the affected extremity insures the best conditions for complete surgical excision. The tourniquet not only prevents hemorrhage during the operative procedure but also prevents red discoloration of the exposed tissues of the operative site. This discoloration interferes to a great degree with the accurate identification of tissues that is essential to the delicate dissection required for the removal of a ganglion. The objection to general anesthesia will be minimized by the use of an intravenous anesthetic agent such as sodium pentothal. With the administration of this agent, anesthesia is produced easily and the after effects are negligible.

It is not our primary purpose in this paper to advocate any hypothesis as to the genesis of the ganglion, but we do believe that the strongest argument appears to lie in favor of the hypothesis of mucinous degeneration of the periarticular connective tissue. There might be predisposing factors such as embryonic rests or cysts, but we do not think that these have been satisfactorily demonstrated.

The work of H. T. Jones and others indicates that the ganglion and the cystic bursal hygroma are the results of one pathologic process and we are in agreement with this concept. For this reason and for others, such as the similarities in histologic structure and fluid contents, we are inclined to classify the ganglion anatomically as an adventitious type of bursa, and from the standpoint of disease, in the class of cystic manifestations along with cystic bursal hygroma. We have mentioned the matter of function as an objection to such a classification, but we are of the opinion that the reasons favorable to such a consideration outweigh this objection and others.

SUMMARY

Thirty-seven cases of bursitis have been encountered over a period of six years. These cases were susceptible of classification on an etiologic basis into acute and chronic types, each of which was further

subdivided. Forty-one bursae were removed surgically and to our knowledge, only eight of these have recurred since operation. Eight known different diseases affected the forty-one bursae which were removed and trauma was the most common cause of chronic bursitis in this group of cases. Complete excision is the procedure of choice in the treatment of chronic bursitis that is associated with persistent swelling and disability. Chronic subdeltoid bursitis should be treated conservatively, unless such measures have proved to be ineffective.

One hundred two cases of ganglion have been encountered over a period of six years. These cases represented 104 ganglions, in the treatment of which 115 surgical procedures were used. The ratio of males to females was 1:3. Of these 102 cases, permanent results of treatment have been determined in seventy-one. From all methods of treatment, good results occurred in 59 per cent of cases. Of the various treatments employed, complete surgical excision of the sac offered the best results.

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"Weeping sinew" or "ganglion" (tenosynovitis) forms a fluctuating, spindle-shaped swelling along one of the tendons of the wrist, slow and almost painless in its course.

Case Reports

THYMOMA—AN UNUSUAL CASE*

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EWING[1] classifies thymic tumors into two main groups: (1) Lymphosarcoma or thymoma which is the most common form of thymus tumor, and (2) carcinoma which arises from reticulum cells.

Ewing[2] states that their weight at birth is 2 to 14 Gm., averaging 7.7 Gm., and they increase in size to the fifteenth year when the average weight is 20 to 28 Gm. A strict encapsulation has been an outstanding feature.

Parker[3] states that the first operative treatment of thymus tumor to relieve respiratory distress in man was given by Rehn in 1896.

In 1907, Jackson[4] was the first to observe tracheal stenosis by means of the bronchoscope in a patient with a large tumor of the thymus.

Ochsner and Doubler[5] mention that the thymus and the sexual organs in man and in animals work antagonistically, and the removal of the thymus gives rise to hypertrophy of the testicle and vice versa.

Helvenstine[6] shows that the thymus, being of both mesodermal and entodermal origin, may give rise to sarcoma, carcinoma or mixed carcinosarcoma tumors. He reports two of his cases and states that Rubaschow was able to collect sixty-nine cases of thymic tumors, fifty-two of which were sarcoma and twelve carcinoma.

Jones[7] reports a thymus tumor in a patient with myasthenia gravis and he states that in fifty-six autopsies of myasthenia gravis recorded since 1901 about half the cases showed thymic involvement.

Speed[8] experienced a case of a large thymic tumor with metastasis to the supraclavicular space and enlargement of the thyroid with symptoms of hyperthyroidism. The importance of a roentgenogram in this type of case with bulging in the neck was stressed.

In their report Symmers and Vance[9] state that lymphocytic tumors occur most often in persons under thirty-five; of those many are in children.

Bren and Wechsler,[10] in their two cases reported, bring out the association of myasthenia gravis with sudden death. The autopsies showed tumors of the thymus gland; both their cases had been previously diagnosed as encephalitis.

Symmers[11] reviewed a large series of twenty-five of his own collected cases from Bellevue Hospital, New York. He brings out the absence of early signs and states that at least five different types of growth are likely to arise from the thymus gland, namely, perithelioma from the connective tissue of the walls of small blood vessels, lymphosarcoma from the lymphocytic elements, endothelioma from the endothelial reticulum cells, spindle-cell sarcoma from the connective tissue framework and Hodgkin's disease which finds the necessary prerequisite for development in the lymphocytes of the thymus.

Crosby,[12] in 1932, reviewed all the literature and brought the subject of malignant

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tumors of the thymus up to date with a total of one-hundred sixty-six cases, of this large group one-hundred twenty-two were so-called sarcomas and forty-four were carcinomas. He states that the term thymoma was first used by Grandhomme in 1900.

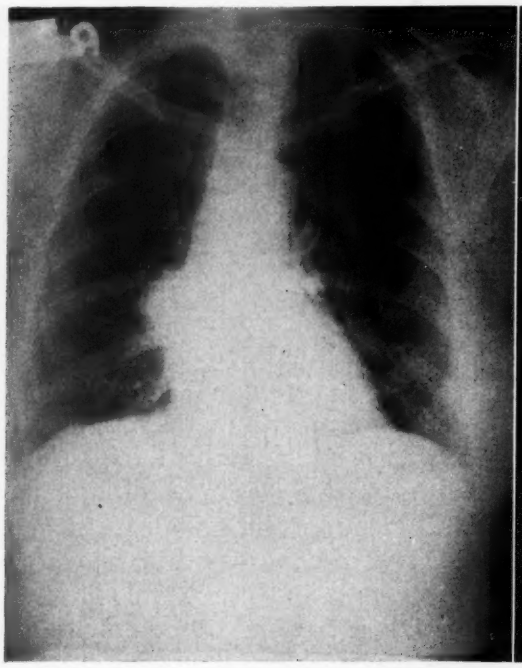

FIG. 1. Showing a rounded mass above the right auricular curve, projecting into the right lung field.

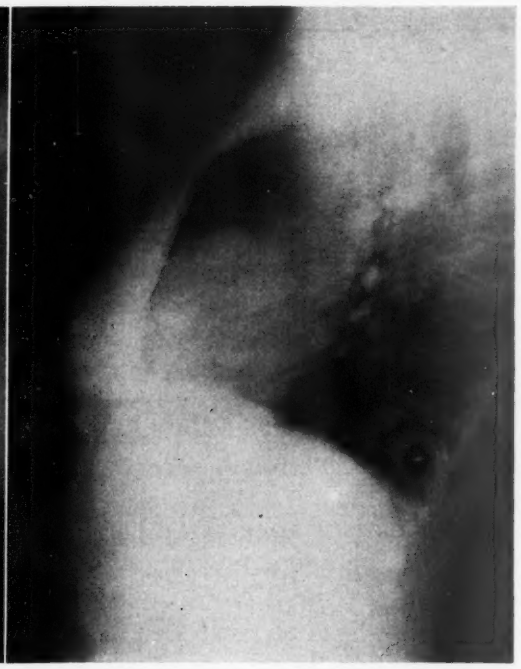

FIG. 2. Lateral view revealing mass lying anterior to heart shadow.

Norris,[13] in 1936, stated that 50 per cent of reported autopsied cases of myasthenia gravis showed some thymic involvement. He reports four cases of thymomas with typical myasthenic symptoms such as difficulty in mastication, restlessness, dysphagia and spasmodic dyspnea.

Janeway,[14] in 1920, reported on three cases of tumors of the anterior mediastinum treated with radium with encouraging results. He infers that radium and *x*-ray offer to some definite relief with a prospect of cure.

Craver[15] admits that some thymic tumors are radioresistant. A good point he brings out is that treatment by *x*-ray is an important differentiating procedure in the differential diagnosis between aneurysm and thymic tumor.

Henson,[16] speaking of thymic enlargement in children with symptoms, states that they are best not operated upon; if absolutely necessary a preoperative course of *x*-ray should be given.

Andrus and Foot[17] report a most unusual case of thymic tumor in a boy aged thirteen with the largest tumor reported up to that time, weighing 2,235 Gm. It was removed surgically with the recovery of the patient.

Rogatz,[18] in May 1939, reviews the clinical studies and autopsy findings in an infant two and one-half months of age with lymphosarcoma of the thymus.

CASE REPORT

The patient, a white female, aged sixty, was admitted to the Millard Fillmore Hospital on December 2, 1937, complaining of shortness of breath. Over a period of years this had gotten progressively worse until she could hardly walk around the house. In the four months previously she had developed paroxysmal coughing attacks which came on at any time. Talking had become increasingly difficult as it brought on attacks which exhausted her completely. She had had nocturnal dyspnea since May 1937. No hemoptysis had been present although she at times expectorated some brownish mucus. There were no night sweats. She had

lost a few pounds recently, and had developed some fear of eating, as the excessive coughing at times resulted in nausea though she seldom vomited. The patient also complained of being tired, but that she could not rest or sleep due to the aggravating cough.

She had had whooping cough, measles and mumps in childhood. There was no history of tuberculosis, diabetes or cancer in the family.

Examination revealed a well nourished, somewhat obese, white female aged about sixty, with an anxious expression. She was slightly dyspneic in bed. No clubbing of the fingers was seen. The positive physical findings were confined largely to the chest.

There was a moderate enlargement of the thyroid gland. The throat was negative for pathology. Chest movements on respiration were free and equal on both sides. The trachea was not displaced. Auscultation of the lungs disclosed crackling râles in the right apex anteriorly, musical and crackling moist râles throughout the right chest posteriorly. The heart was regular and of fairly good tone; no murmurs were heard. There appeared to be widening of the base of the heart both to right and left. The pulse was of good quality; the blood pressure taken lying down in bed in the right arm was 130 systolic, 76 diastolic; the left arm was 114 systolic, 60 diastolic. The abdomen was obese, not distended. The liver edge could be made out about two finger-breadths below the right costal margin; it was not tender and no other masses could be felt. The lower extremities were negative, no edema being present.

The urine on several occasions was negative except for an occasional granular cast. Her blood on admission showed 80 per cent hemoglobin 4,264,000 erythrocytes, 8,800 leucocytes: 62 per cent neutrophiles, 38 per cent lymphocytes. On examination the sputum showed a moderate number of pus cells, a moderate number of organisms including staphylococci and streptococci; no acid-fast bacilli were found. The Wassermann test was negative. Roentgenograms taken of the chest revealed a moderate emphysema in both lung fields. The heart shadow appeared normal in size but revealed a rounded mass projecting from its right border just above the right auricular curve, the mass being about 2½ cm. in diameter and projecting into the right lung field. Fluoroscopically this shadow appeared inseparable from that of the heart, lying slightly anteriorly and showing pulsation. A kymographic study revealed that this pulsation was identical with that of the auricle.

FIG. 3. Kymographic study showing pulsation identical with that of the auricle.

In the absence of a positive diagnosis by roentgenography and to rule out a bronchogenic tumor the patient was bronchoscoped on December 6, 1937, using local anesthesia. The examination revealed no pathology within the bronchi.

In view of the history and the tumor mass seen on *x*-ray with negative bronchoscopy findings a diagnosis of a right mediastinal tumor was made and an exploratory operation to determine its operability was performed on December 8, 1937.

The patient was anesthetized with cyclopropane and an incision was made from a point just beneath the right clavicle in a curved manner to a point opposite the anterior cartilage of the fourth rib at its sternal junction. The sternum and ribs were exposed and the cartilaginous portions of the second, third and fourth ribs removed. In order to get a better exposure a portion of the sternum at this location was rongeured away reducing its width at this point to about one-half. The pleura and pericardium were seen and the tumor mass could be palpated through the pleura and

appeared to pulsate with the heart beat. The pleura was incised. The underlying tumor mass had a whitish gray appearance.

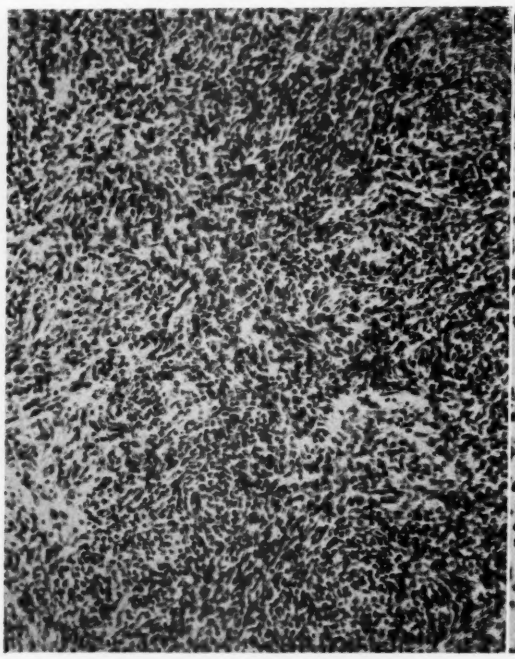

FIG. 4. Photomicrograph of tumor tissue showing spindle cells in whorls with diffuse lymphocytic infiltration. × 100.

FIG. 5. Photomicrograph showing spindle cells in whorls; diffuse lymphocytic infiltration. Order of growth suggests endothelial proliferation. × 750.

A mediastinal tumor measuring about 9 by 7 by 4 cm. was exposed. The tumor was adherent to the pericardium over the right auricle, the upper portion being on a level with the arch of the aorta. The capsule of the tumor was incised and the tumor shelled out with comparative ease. Its attachment on the medial side was clamped, cut and tied off with chromic catgut and the wound was closed. The pleura was sutured with a continuous layer of chromic catgut, the muscles sutured together and three kaldermic retention sutures placed through the skin, subcutaneous tissues and fascia. The skin was closed with Michel clips. The operation lasted forty-seven minutes and the patient stood the procedure very well, being returned to her room in good condition.

The first five postoperative days were quite uneventful the temperature never rising above 102°C. rectally and dropping to 99°C. orally the second postoperative day. The pulse varied between ninety and one-hundred-ten per minute and was of good quality; respirations ranged between eighteen and twenty-eight per minute. The patient was given oxygen postoperatively because of thick mucus in her throat which was difficult for her to "bring up."

On the second postoperative day the patient commenced to cough and complained of considerable mucus in her throat with inability to "bring it up," the mucus being quite thick and tenacious. Oxygen was administered to combat this. Five days following her surgery the patient was still coughing and now began to cough more violently and at times continuously. About this time she complained of pain in her chest at the operative site. The dressing was changed and the wound appeared to be normal. The chest was strapped with adhesive tape to limit excursions of the anterior chest wall. Oxygen was continued at frequent intervals and helium was also administered, using 80 per cent helium and 20 per cent oxygen. However, the coughing continued and was very harassing, not responding to the usual medications.

On the seventh postoperative day the patient complained of pain at the site of her operation and a peculiar instability of the front of her chest with a thudding sound and a rubbing sensation at her sternum when she coughed or breathed. Examination at this time revealed a definite break in the sternum with some over-

lapping of the fractured fragments; the thud could be heard on respiration. The coughing at this time was painful, frequent and severe.

On December 15, 1937, the patient was again taken to the operating room and under cyclopropane anesthesia an incision was made over the midsternum disclosing a complete fracture in its upper portion through the previously rongeured area. The fragments were overriding. A four hole Lane's plate was screwed into position to maintain reduction. No evidence of infection was seen. The wound was closed in layers. The patient was returned to her room in fair condition.

Following this procedure the patient's condition became progressively worse; her coughing was not improved; there was some cyanosis when the oxygen administration was stopped, and she was expectorating yellowish, thick mucous. The patient's condition declined, her temperature rose to 103.5°C. rectally, pulse one-hundred-forty per minute, respirations shallow and to thirty-eight per minute. She expired December 16, 1937.

I quote here the pathologist's report: "Gross examination of the tumor shows a lobulated, irregularly, pear-shaped tumor mass measuring 8 × 7.5 × 3.5 cm. and weighing eighty-five grams. Cut section reveals numerous lobulations of soft, grey-brown tissue. Many of these are enclosed in a thin fibrous capsule. Gross and visible characteristics suggest thymus, having the appearance of sweetbread. Interstitial hemorrhage is present in several lobules. Consistence of tumor tissue is that of fish flesh.

"Microscopic sections of the tumor shows spindle cells, often in whorls and well supplied by capillaries of which the spindle cells form the walls, are diffusely infiltrated by lymphocytes and tend also to form abortive follicular formations around lymphoid cell aggregates. Fibrous stroma is very scant and a few slender trabeculae are noted. Order of growth suggests endothelial proliferation rather than that of a nerve sheath sarcoma. Impression is derived that although locally malignant, this tumor is probably not prone to metastasize. Diagnosis: Thymoma (endothelial type)."

Autopsy was performed and reported by Dr. Norman W. Elton as follows:

"The body is that of a well developed and well nourished elderly female of the pyknic constitution. Body length is 65½ inches.

"Abdominal wall shows numerous old striae of previous pregnancy. Eyes are not examined, since the head and face have been prepared for funeral. On the anterior chest wall there are two long incisions one concave outward and parasternal on the right, measuring 20 cm. in length sutured by a continuous dermal stitch. The other, more recent, lies in the midsternal line, is 18 cm. in length, and the skin edges are coaptated by Michel clips. Reopening of the incisions reveals a fracture of the sternum just below the sternomanubrial junction, repaired by a four-screw metal plate of Lane type. This plate is lifted out without difficulty, screws coming readily out of sternum. Right border of sternum in the region of the second and third ribs has been ronguered with removal of half its substance. To facilitate examination the complete sternum is removed, exposing the tumor site in right upper pericardium mesial to parietal pleura. Base of the tumor site is markedly thickened and indurated and grossly appears to consist of unremoved tumor tissue. Parietal pleura lateral to the tumor site has been sutured. Base of the tumor site measures some 7 × 4 cm. with a ragged meaty surface.

"*Lymph-nodes* of upper and posterior mediastinum are markedly enlarged, with black centers and pale peripheries on cut section. Nodes at bifurcation of trachea are especially large, one measuring 2 × 4 × 2 cm.

"*Right diaphragm* attains the fourth rib; and the *left diaphragm* is also at the level of the fourth rib. Presence or absence of fluid in pleural cavities cannot be determined because of escape of embalming fluid, but both lungs are voluminous and fill the pleural cavities completely. *Left lung* weighs 525 grams; *right lung* weighs 700 grams. Each is rubbery in consistence and an abundance of clear frothy fluid pours from their cut surfaces on squeezing. Posterior surface of right lower lobe exhibits several old fibrinous plaques in visceral pleura. There is no evidence of pulmonary tumor metastasis. *Heart* weighs 300 grams. Its myocardium is firm and beefy red and all valves and coronaries are normal. Heart measurements are as follows:

	Cm.		Cm.
AV	—6.5	PV	— 8.0
MV	—7.0	TV	—11.0
TLV	—1.9	TRV	— 0.5

"Trachea is of somewhat reduced caliber. Aortic intima is smooth and shining.

"*Abdominal cavity* is explored through the diaphragm. Bowel is greatly distended with gas. No stones are palpable in the gallbladder. Uterus and adnexa are not remarkable. *Kidneys* are firm and normal in shape and size. *Spleen* is small and firm. *Liver* is somewhat enlarged, but its lower edge is sharp. It is yellow on cut section with poor definition of anatomical markings.

ANATOMICAL DIAGNOSIS

1. Upper mediastinal tumor with operation therefor, and residual tumor tissue in anterior upper pericardium.
2. Pulmonary edema.
3. Traumatic fracture of sternum and operation therefor.
4. Mediastinal lymphadenopathy.
5. Fatty infiltration of liver.

MICROSCOPIC SECTIONS

"*Lymph nodes* from the mediastinum show only reticular hyperplasia and dilated vascular channels containing many polys. There is no evidence of tumor.

"*Lung:* Pleural mesothelium shows a marked thickening due to proliferation of histocytes, some of which are multinucleated. Beneath this area many groups of alveoli contain a purulent exudate. Reaction is also noted about bronchioles.

"*Liver:* Bile retention grade 1. There is also a low grade fatty infiltration. Stroma shows light lymphocytic infiltration, with foci of increased density.

"*Tumor site* shows only recent intensive fibroblast proliferation involving fatty tissue. No residual tumor is noted.

MICRO DIAGNOSIS

1. Bronchopneumonia
2. Acute mediastinal lymphadenitis

FINAL DIAGNOSIS

1. Thymoma (endothelial type) and operation therefor
2. Pulmonary edema
3. Bronchopneumonia
4. Traumatic fracture of sternum and operation therefor
5. Acute mediastinal lymphadenitis
6. Fatty infiltration of liver"

CONCLUSIONS

1. We believe that in a similar case it is unnecessary to rongeur away any part of the sternum.
2. Lane plating of the sternum is not feasible as the screws will not hold.
3. The sternum of older individuals is brittle and appears to fracture easily when its width has been decreased.
4. These tumors when encapsulated as the one reported here are easily shelled out and removed.
5. We believe that this patient had an excellent chance of recovery had she not fractured her sternum.

SUMMARY

A case is reported of an operated comparatively nonmalignant, rare, mediastinal thymic tumor, with endothelial characteristics, weighing 85 Gm. and with its capsule attached to the pericardium of the right auricle. The clinical and pathologic features are discussed along with a review of the literature to date. It did not present the often accompanying signs of myasthenia gravis.

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Owing to its connection (thyroid tumor) with the larynx it moves up and down somewhat when the patient swallows, but is not attached to any other structures in the neck. The enlargement is often unilateral or largely so.

RETROPERITONEAL MULTILOCULAR CHYLANGIOMA CYST WITH CALCIFICATION*

REPORT OF A CASE

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AND
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CHYLANGIOMAS are considered benign cystic tumors of the lymphatic system. They are rare conditions and belong to the group of retroperitoneal cysts. Most of the records of retroperitoneal cysts are to be found in postmortem findings or reported as accidental discoveries made during surgical intervention for a mistaken diagnosis which, in case of larger tumors, was frequently ovarian cyst. Clinical diagnosis is seldom made before operation even today.

The following case report is comparable to two other cases which are the only ones available in the literature. It is especially interesting since the clinical diagnosis could be made before operation from the location of the cyst, and from the unusual roentgenologic findings.

CASE REPORT

M. B., a white girl, aged 5 years, was admitted to Gouverneur Hospital on December 8, 1938. According to the father's description, one week prior to her admission he had observed that the child's skin became yellow and that the child passed red urine. Four days later, the child vomited twice; two days after that the patient complained of abdominal pain in the region of the epigastrium.

The history of the patient's early infancy was negative. At 2½ years, the child had had measles followed shortly thereafter by whooping cough. At 3 years of age pneumonia was contracted. Four years prior to the present admission, a hemangioma had been removed from the region of the patient's left calf at Gouverneur Hospital. Two years later the child was operated upon at another hospital, when a cavernous hemangioma was partially excised from the lateral surface of the left thigh. It is interesting to note that one year previous to her present admission, roentgenograms of her extremities and chest were taken but none of her abdomen, therefore, her described condition remained unknown until abdominal symptoms appeared. The site of the operation became infected and responded sluggishly to treatment.

The family history was negative. Father, mother and two siblings were living and well.

Physical examination revealed the following pertinent findings: The patient was a well-nourished, white girl who was lying in bed in no apparent distress. Her eyes showed an icteric tinge to the sclera. The mucous membranes of the nose were injected. The ears were negative. Her neck showed no lymphadenopathy. Heart and lungs were normal. Abdominal examination revealed a soft, non-tender abdomen. The liver margin was palpable 2½ fingers below the costal margin at the right mammary line. The edge of the liver was smooth, and not tender. Neither spleen nor other masses were palpable. There was a small healed scar at the left side of the lower abdomen. Near the interrectal cleft, there was a hemangioma measuring about 2½ × 1 cm. A small pedunculated skin tag was located near the anus. In addition, there were many other hemangiomas ranging in size from a pinhead to ½ cm. mostly on the left lower extremities, but also sparsely scattered over the other extremities and the body. Genitalia and rectum were negative. The extensor surfaces of the elbows and knees showed patches of psoriasis. A healed scar was present on the lateral aspect of the left leg.

The admission diagnosis was: (1) acute catarrhal jaundice; (2) multiple hemangiomas; and (3) psoriasis.

* From the Department of Surgery, Gouverneur Hospital.

Routine flat plate examination of the abdomen revealed a large circumscribed shadow in the left iliac region, measuring about 7½ × 9½ cm., situated rather posteriorly in the abdomen. (Fig. 1.) A side view showed the same at the posterior abdominal wall. (Fig. 2.)

FIG. 1. Flat plate of abdomen. The calcified deposits in the cyst wall clearly outline the cyst situated in the left lower quadrant of the abdomen.

FIG. 2. Flat plate of abdomen; lateral view. The situation of the cyst in this view suggests its retroperitoneal location.

An intravenous urogram was done to determine the association between the cystic mass and the urinary tract. (Fig. 3.) Both kidneys showed normal function. The pelves and calyces of both kidneys were completely filled in outline with no dilatation. The urographic studies showed the presence of a large cystic mass in relation to and apparently causing dilatation of the left ureter. The lack of mobility of the mass, its location and relationship to the ureter suggested that it was situated retroperitoneally. The right ureter and bladder were normal. Retrograde pyelography (Fig. 4) confirmed these findings and established the fact that both kidneys were normal in size, shape and position.

A barium enema examination showed the colon to be completely filled from the rectum to the cecum with no defect in outline. The large mass in the left side of the abdomen was found to be located outside the colonic tract. (Fig. 5.) An attempted pneumoperitoneum examination contributed little towards the further differentiation of the mass. Examination of the chest and long bones was radiographically negative.

It is interesting to note that repeated abdominal examination over a period of several weeks and by many examiners failed to reveal a palpable mass, although the presence of this mass had been thoroughly demonstrated radiographically. However, shortly after ether anesthesia was employed for retrograde pyelography, the mass could be felt definitely. Clinically, the mass at this time was reported as cystic located on the left side of the abdomen, the upper pole of which measured about 5 cm. below the left costal margin and the lower pole about 3 cm. above the anterior superior spine. Two days after the anesthesia had been administered, the mass was no longer discernible on palpation.

Laboratory studies were replete with negative findings. Urine examinations were re-

peatedly negative for bile, albumin and sugar; specific gravity varied from 1.010 to 1.030. Fecal specimens were negative for typhoid, paratyphoid or dysentery. Blood chemistry findings were: N.P.N. 28, sugar 109, icteric index 8, cholesterol 139, cholesterol esters 93, total protein 6.9 per cent, albumin 3.3 per cent, globulin 3.6 per cent.

Fig. 3. Intravenous pyelogram. The left ureter is slightly dilated. The cyst lies just lateral to the ureter and is evidently exerting pressure thereon.

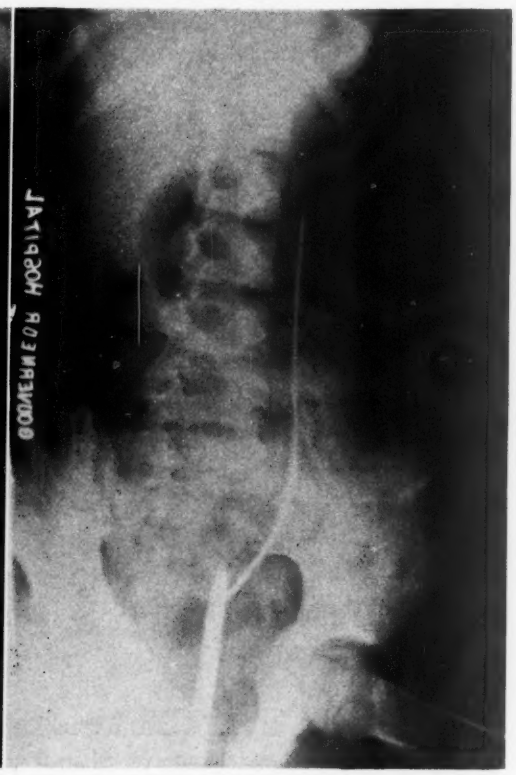

Fig. 4. Retrograde ureteroscopy; oblique view. This view demonstrates the extra-urinary location of the cyst.

To avoid complications, it was believed that surgical removal of the mass was indicated.

Operation. The abdomen was opened through a left external rectus incision. The cyst was easily identified as it presented internal to the descending colon and protruded well into the abdominal cavity. An incision into the peritoneum was made parallel to the external border of the descending colon. The colon was dissected medially exposing the fibrous coat of the cyst. (Fig. 6.) Blunt enucleation of the cyst could not be done because of the fibrous attachment to the retroperitoneal structures. A careful dissection of the cyst was made during which it was freed from the ureter which ran across the anteromedial surface. The quadratus lumborum and psoas muscles were blended on their anterior surfaces with the cyst wall in the manner characteristic for hygromas found adjacent to muscle tissue in other parts of the body.

The wall of the cyst was perforated during the dissection of the upper pole from the fatty capsule of the kidney. A strand of fibrous tissue was noted attached to the upper pole which ran behind the kidney and extended upward, in the kidney space toward the left crus of the diaphragm. Upon opening this strand of fibrous tissue, a cavity with a lining resembling the wall of the larger cystic cavity was found. With the probe in place the fibrous tract was dissected out up to and behind the crus of the diaphragm where it ended near the twelfth dorsal vertebra. (Figs. 6, 7 and 8.)

Repair of the opening in the posterior peritoneum was performed, which replaced the descending colon. A drain was inserted through the lower angle of the wound into the kidney space.

The postoperative course was uneventful. Follow-up examination showed the child apparently well. (Fig. 9.)

DISCUSSION

In this retroperitoneal multilocular cyst with calcification the cavities were not in direct communication. The cystic material resembled a seromucinous substance and only the larger cyst was walled with extensive calcareous deposit. Goedel's[1] postmortem finding in a man of 20 is very interesting as it bears some relation to our case. In this case there was a multilocular chylangioma of the mesentery of the hepatic flexure, intraperitoneally and retroperitoneally. The latter was located behind the ascending colon in the angle between the vertebral column, right kidney and liver. The cyst showed endothelial lining surrounded by proliferating connective tissue stroma. In some of the old, thick-walled cysts the endothelium had entirely disappeared, and there remained only calcified detritus. It is supposed that younger, thin-walled cysts are lined with endothelium, and its absence may be explained by the fact that the endothelium, in time, undergoes hyaline and fatty degeneration and is absent in cysts of long duration.

Smoler[2] noted that the presence and absence of endothelial lining of the cyst wall are reported by equal numbers of authors. In all cases there seems to have been a lining of the lymph spaces within the cyst wall proper. Whether these cysts develop from varicosities of the preformed lymph vessels, or should be classed as new growths or retention cysts, is a matter still under discussion.

The second report that is related to this case is that of Swartley.[3] This concerned a girl, 7 years of age, with a mesenteric cyst of the ileum the size of a grapefruit. The wall showed three layers: inner serous, middle muscular and a thick fibrous envelope undergoing calcareous changes.

Etiology. Retroperitoneal cysts are believed to develop from the congenital remnant in the mesentery or retroperitoneal space of the Wolffian and Müllerian ducts or from the vitelline ducts in connection with Meckel's diverticulum. Such cysts are found in all ages but more frequently in young females. Hadley[4] states that cysts are formed as a result of the abnormal development of the primitive lymph sac. According to Dowd:[5] "Chylous cysts are really pre-formed cysts situated in such close relation to the lacteals that chyle has been effused into them and that they are really embryonic in origin, in structure similar to ovarian and parovarian cysts." Cysts may also originate in degenerated lymph-nodes as is occasionally observed elsewhere in the body. (Rokitansky, Virchow.) The lymphatic and chyle cyst may also develop under certain circumstances as a result of obstruction in the retroperitoneal lymph system. This, however, must be rare because of the collateral circulation (Gerster).[6]

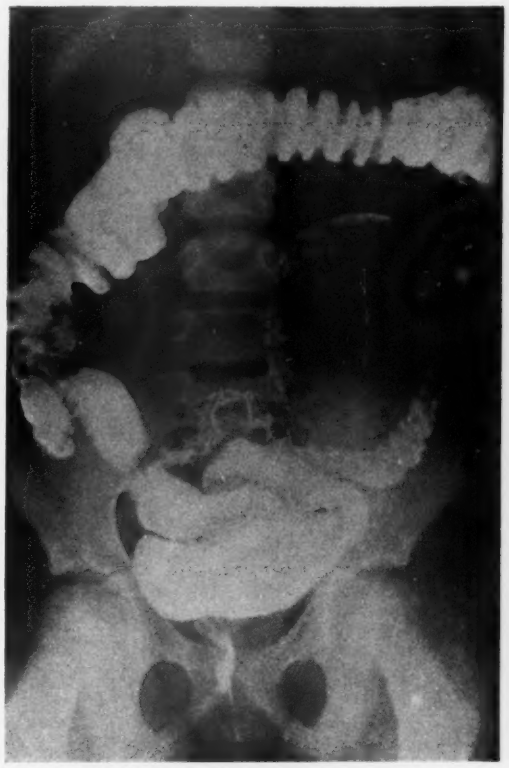

Fig. 5. Barium enema examination. The cyst is demonstrated to be extracolonic and to lie medial to the descending colon.

Location. These cysts may be located anywhere in the mesentery of the small or large bowel or in the omentum. Retroperitoneally they are more frequent at the right

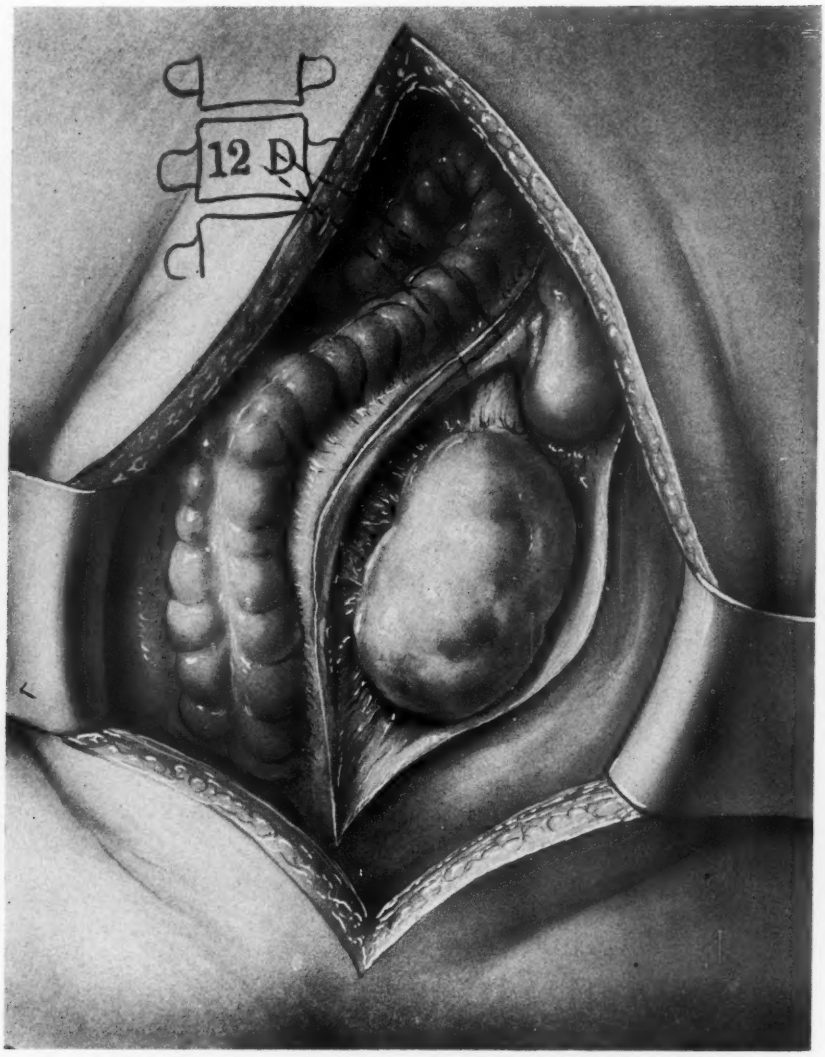

FIG. 6. The operative approach, appearance and location of the cyst.

FIG. 7. Gross specimen. The cyst, which had been opened before this photograph was taken, has been folded back and reshaped to simulate its original shape and size at operation.

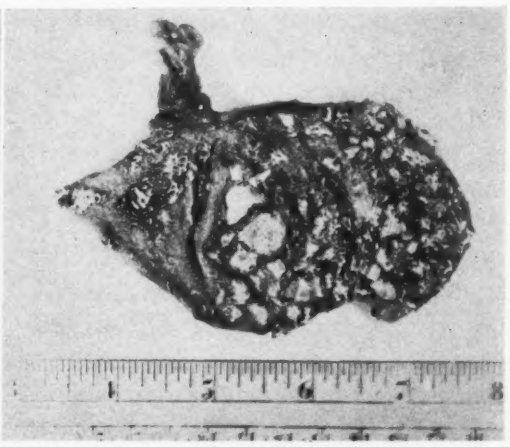

FIG. 8. Gross specimen. The cyst has been opened and flattened out. The white areas are calcific deposits in a wide variety of size ranging from minute deposits to calcified plaques ½ inch in diameter.

or left lower quadrant of the abdomen but may be found at any other location of the posterior retroperitoneal space.

Classification and Origin. The retroperitoneal cysts are classified according to Hanfield-Jones[7] as urogenital, mesocolic, inclusion, lymphatic, traumatic, blood and parasitic retroperitoneal cysts. Lahey[8] groups the mesenteric, omental and retroperitoneal cysts together as retroperitoneal cysts since they are all merely an anterior extension or inclusion of the originally retroperitoneal structure. This, of course, may be true for the cysts of congenital origin, but we cannot accept this classification for all mesenteric and omental cysts as some of them may be formed later in adult life by obstruction of chylous, lymphatic ducts, traumatic blood cysts, or by parasites, etc. Therefore, the designation of omental and mesenteric cysts is justified in contrast to retroperitoneal cysts.

All these cysts according to Moynihan[9] may be: (1) serous, (2) chyle, (3) hydatid, (4) blood, (5) dermoid and (6) malignant retroperitoneal cysts.

The retroperitoneal chylous cysts are actually cystic lymphangiomas. They are unilocular or multilocular. Generally they contain chylous, milky, mucinous, serosanguinous, bloody or straw-colored fluid. Dermoid cysts contain sebaceous material, hair or teratoid tissue. The cysts are thin or thick-walled tumors, usually benign. Warfield[10] found malignancy in less than 1 per cent. Malignant cystic tumors are usually sarcomas.

Some such cysts may be differentiated also by the naked eye, e.g., the urogenital cysts are bluish, thin-walled, single cysts containing clear serous fluid and are situated near the kidney. One of the varieties of the urogenital cyst is the fimbriated Müllerian cyst. The mesocolic cyst, according to Hanfield-Jones,[7] is formed during the rotation of the colon between the mesentery and parietal peritoneum. Among the inclusion cysts, the dermoid and the teratomatous cysts are rare and do not differ from similar cysts found elsewhere in the organism. In parasitic cysts usually echinococci have been observed. The omental, mesenteric and retroperitoneal cysts

Fig. 9. Postoperative flat plate of the abdomen.

are not common findings. There are about 550 cases reported in available literature, but one may assume that many such findings remain unreported. However, according to Dr. Gerster, the most careful search in the literature reveals only sixteen or eighteen retroperitoneal cysts. Therefore, ours may be considered as the nineteenth, and the third in which calcification was noted.

Pathology of Specimen in Reported Case. According to the pathologist, Dr. M. Kopel, the gross specimen consisted of a cystic mass measuring about $5 \times 5 \times 6$ cm. which had been opened and flattened out. The wall of the cyst was 2 mm. thick and contained many irregular patches of calcified tissue. (Fig. 8.) The surface of the cyst was fibrous, hemorrhagic, discolored and showed some dilated blood vessels. In some areas the lining was rough and had the appearance of squamous epithelial

tissue. Microscopic examination showed that the cyst wall was composed of dense fibrous tissue which in some areas was calcified. Thickened blood vessels were present; in some areas the lining of the cyst consisted of a calcified plaque. In others, small papillary projections were seen lining the cyst. No definite epithelial layer was seen, however. The pathologist's diagnosis was: retroperitoneal, multilocular, calcified cyst.

Symptomatology. Reviewing the findings of Moynihan,[9] Peterson,[11] Berger[12] and others, one may admit that many such cysts cause no symptoms whatever. This may be the case when they are small with insidious development manifesting only undefined abdominal complaints, which may not interfere with the function of the abdominal organs. Many, however, are admitted to the hospital as acute surgical subjects. In such patients the pain is more or less acute, sometimes localized, and radiates to the groins, thighs or flank. But, according to Berger[12] and Rokitansky, in the majority of cases pain failed to localize. Nausea and vomiting and other signs of intestinal obstruction or peritonitis are present after the cyst has been ruptured or torsion has occurred. Retroperitoneal cysts with a chronic course produce only occasional abdominal pain and indigestion beside the physical findings of the tumor present. Rapid emaciation was noted by Moynihan[9] and marked loss of weight by Berger and Rothenberg.[12] The variation of symptoms may be explained by the location and size of the tumor mass, which is palpable in about 75 per cent of the patients. Abdominal tenderness on examination is frequently present. Percussion may give information with characteristic dullness over the mass, surrounded by an area of resonance. The presence of albuminuria was noted in 50 per cent of the patients by Berger.[12] *X*-ray findings are of great diagnostic value, as illustrated by our reported case. Gerster[6] reported a retroperitoneal chyle cyst also visible on *x*-ray; he pointed out that the higher calcium content of the cystic fluid may have accentuated the visibility of the cyst.

Differential Diagnosis. A clinical diagnosis has been made only exceptionally. These cysts escape attention because of their rarity or the fact that they are masked by an acute condition. They are frequently diagnosed as ovarian cyst, cyst of the kidney, abdominal tumor such as that of the kidney, liver, gall-bladder, spleen or pelvic tumor, also as cyst of the urachus, pancreas or cold abscess. Space does not permit a detailed discussion, but it seems to be a good plan to have a systemic *x*-ray examination to aid in the diagnosis. To reach a fairly accurate diagnosis the elimination of urogenital and gastrointestinal pathology is a prerequisite.

Complications and Treatment. Such cysts after reaching sufficient size (2 to 4 inches in diameter) may compress adjacent intestinal loops, thus causing partial or total obstruction. Peritonitis may occur from rupture or torsion of the cyst. Compression of the ureter may cause hydronephrosis.

Treatment. The treatment is surgical. Complete enucleation is often possible when the line of cleavage has been found and followed. If complete excision is not feasible under the circumstances, simple incision of the cyst followed by drainage or marsupialization has been recommended. Well-planned, but not too extensive surgery prevents postoperative complications. Recovery is usually smooth as it was in our case; however, prognosis depends, as Gerster[6] pointed out, on the patient's general condition at the time of the operation and on the mechanical ease or difficulty of removal or marsupialization.

SUMMARY

A case of retroperitoneal, multilocular, calcified, chylangioma cyst in a girl of 5 years is presented as an unusual finding, inasmuch as the preoperative diagnosis could be made with the help of systematic roentgenograms. Operation was followed by uncomplicated recovery. This case is

comparable to only two other reports in the literature.

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CYSTIC kidneys are usually congenital, but usually produce no symptoms until they have attained a considerable size, and hence are often overlooked or discovered accidentally in patients wholly without renal symptoms.

PRIMARY NONEPITHELIAL TUMORS OF THE STOMACH*

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THERE has been a general belief that nonepithelial tumors of the stomach are rare and discovered only incidentally at the autopsy table. This may be due partly to the fact that all the cases are not recorded in the literature. Although some of these tumors may be symptomless and escape a clinical diagnosis, the majority can be diagnosed clinically and early surgical intervention may give good results.

In a brief review of the literature of the last ten years covering gastric tumors other than carcinoma, we found the majority of such cases on record in foreign literature. Individual case reports are found with an occasional multiple report. These cases consist of both benign and malignant types of tumors. Under benign such growths as leiomyoma, fibroma, neurinoma, dermoid and adenomyoma are found. The malignant group is classified as leiomyosarcoma, fibrosarcoma and lymphosarcoma.

In an extensive review of the literature on leiomyoma of the stomach by Conway,[2] in 1936, he found fifty-six authentic cases of leiomyoma and added two of his own cases. In 1933, Edward and Wright[3] in their review found thirty-eight cases of leiomyosarcoma. Since that date we found twenty-two additional cases in the literature including three of our own cases, bringing the total up to sixty.

The most recent studies made by Taylor,[4] in 1939, show 152 cases of primary lymphosarcoma which includes five of his cases. From his statistical analysis he concludes that 40 to 50 per cent of all gastric sarcomas are lymphoid in origin, and that sarcomas form 1 to 2 per cent of all gastric neoplasma.

Primary lymphosarcoma of the stomach may originate from any lymphatic tissue of that organ, such for example, as from the submucosa lymph follicles. Pack and McNeer[5] classified these into four types grossly: (1) polypoid, (2) ulcerative, (3) multinodular and (4) diffuse infiltrative; and histologically into two types: reticulum cell type and lymphocytic type.

In an analysis of all types of gastric tumors recorded at this hospital in the last ten years, excluding cases not confirmed by histological studies, we find a total of 122. Of this number 115 were carcinomas of various classifications, two benign epithelial tumors and five nonepithelial tumors. Nonepithelial tumors, therefore, show a little over 4 per cent of the total.

We are not concerned at this time with tumors originating from the mucosa of the stomach, but desire to discuss noncancerous tumors of the stomach. Two of the five cases of tumors were reported in 1935.[1] Both were operated on at that same time. It is interesting to note from a recent communication with the surgeon that both of the patients are free from localized recurrence or metastases after five years. Besides these two already recorded we would like to add three more cases of nonepithelial tumors of the stomach:

CASE REPORTS

CASE 1. P. DeR, age fifty, a white, male Italian was admitted to the hospital, August 28, 1937, complaining of cough of about three months' duration, hemoptysis and weakness. With the onset of cough and hemoptysis, the patient noticed progressively increasing weakness, dyspnea and night sweats. Prior to this time he had no complaints. His appetite was always good. There was no nausea or vomiting, diarrhea or melana. He admitted occasional constipation. For three days prior to admission he noticed a marked weakness of his left arm. His past history and family history were negative.

* From the Department of Pathology, Isaac Kaufman Foundation, Montefiore Hospital, Pittsburgh, Pennsylvania.

Examination revealed a well developed, well nourished, white adult male with marked pallor and a slight greenish-yellow tinge to the skin. liver and spleen was not palpable. No tenderness was present. There was edema of the right hand and paralysis of the right arm. Lymph

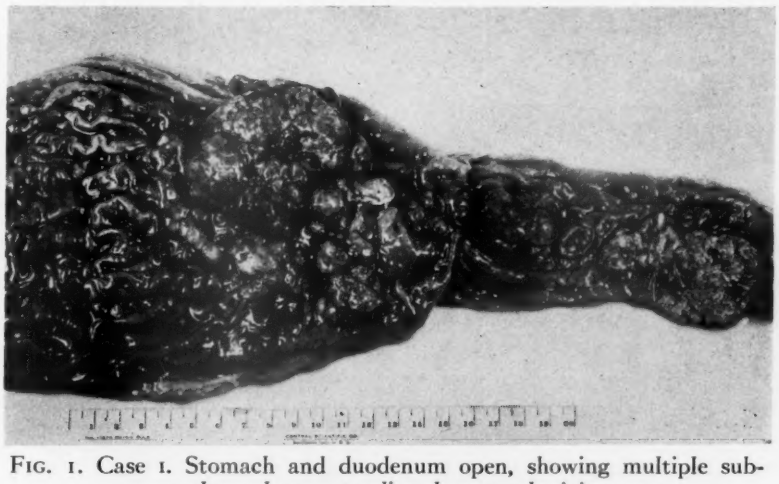

Fig. 1. Case 1. Stomach and duodenum open, showing multiple submucosal neoplasm extending down to the jejunum.

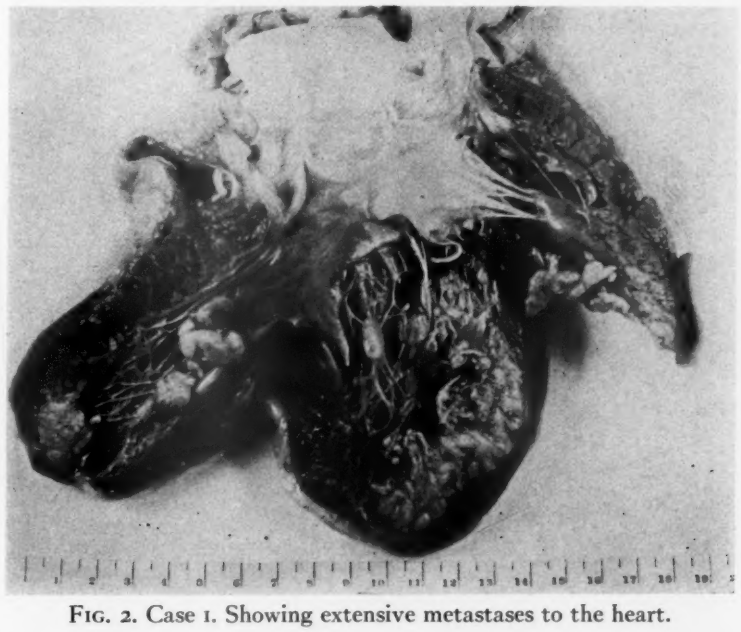

Fig. 2. Case 1. Showing extensive metastases to the heart.

He was perspiring profusely, had a moist cough, and pulse of 120, respirations 42 and temperature 103°C.

A small nodule was palpable in the left cervical region, one over the left anterior chest and in the right upper quadrant of the abdomen. His heart was enlarged to percussion with a soft systolic murmer at the apex. There was impaired resonance of both lungs posteriorly more marked on the right side; numerous moist musical râles throughout the lung fields. Breath sounds were diminished on the right side. The abdomen was soft, rounded and distended. The nodes were palpable in the left axilla; few mesenteric nodes were palpable; also inguinal and left cervical. *X*-ray showed a marked increase in the size of the liver and an increased density in the middle portion of each lung, suggesting the possibility of an infiltration or of an infarction.

Laboratory findings showed hemoglobin of 21 per cent, red blood count of 1,440,000, white blood count of 21,150, polymorphonuclears 92 per cent and lymphocytes 8 per cent. Impressions: malignancy of lung, acid fast infection, blood dyscrasia with profound anemia and pos-

Fig. 3.

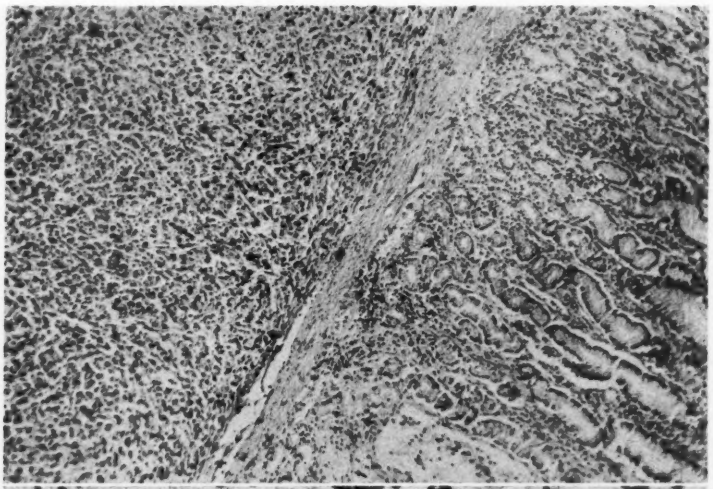

Fig. 4.

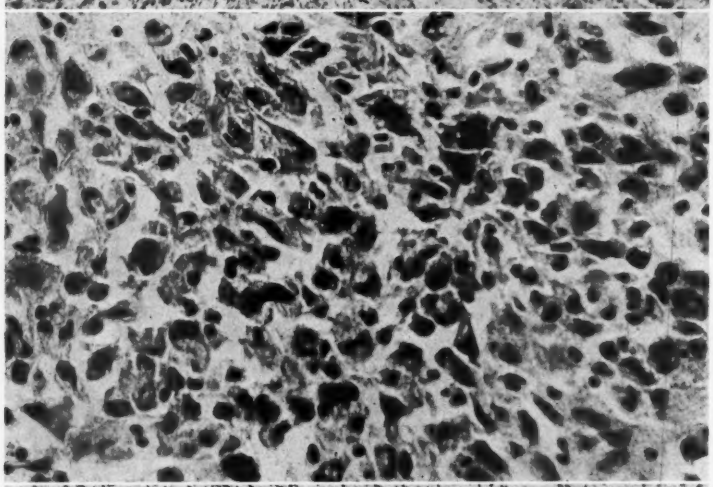

Fig. 5.

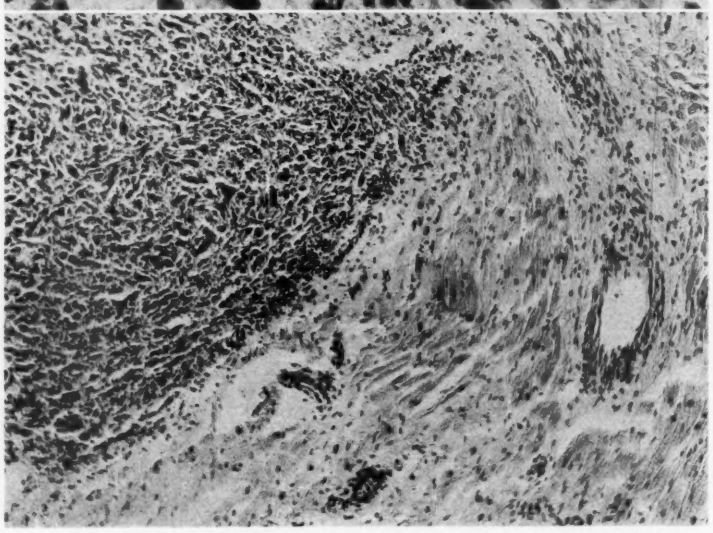

Fig. 3. Case 1. Showing circumscribed tumor separated from mucosa of the stomach by muscularis mucosa; hematoxylin and eosin stain; low power 100 ×.

Fig. 4. Highly undifferentiated cells, pleomorphic, hyperchromatic and numerous mitotic figures (leiomyosarcoma); hematoxylin and eosin stain; high power 400 ×.

Fig. 5. Case 1. Metastasis to the myocardium; low power 100 ×.

sible lues before *x*-ray; after *x*-ray the possibilities of endocarditis with infarcts and mural thrombus were added. While being prepared for transfusion, the patient expired, and autopsy was performed.

The gross anatomical findings showed blood-tinged fluid in the peritoneal cavity and numerous pinkish-grey nodules on the omentum. The largest one was 2 cm. in diameter. The stomach showed multiple soft masses protruding into the lumen, located at the greater curvature extending all the way down into the duodenum. The largest tumor measured 6 by 5 by 3 cm. showing necrotic center and evidence of hemorrhage.

There were no gross evidences of metastases to the liver, spleen, pancreas, kidneys and adrenals. The left pleural cavity showed a small amount of hemorrhagic fluid. The upper lobe of the left lung was fixed to the chest wall. Two small nodules found at the junction of the upper and lower lobes extending into the lung were soft, pinkish-grey in color and grossly resembled those found in the stomach.

The peribronchial lymph nodes were slightly enlarged. The heart was markedly enlarged and

Fig. 6. Case 11. Showing the tumor and small portion of the stomach wall.

Fig. 7. Case 11. Cross section of the tumor; note the encapsulation to the tumor.

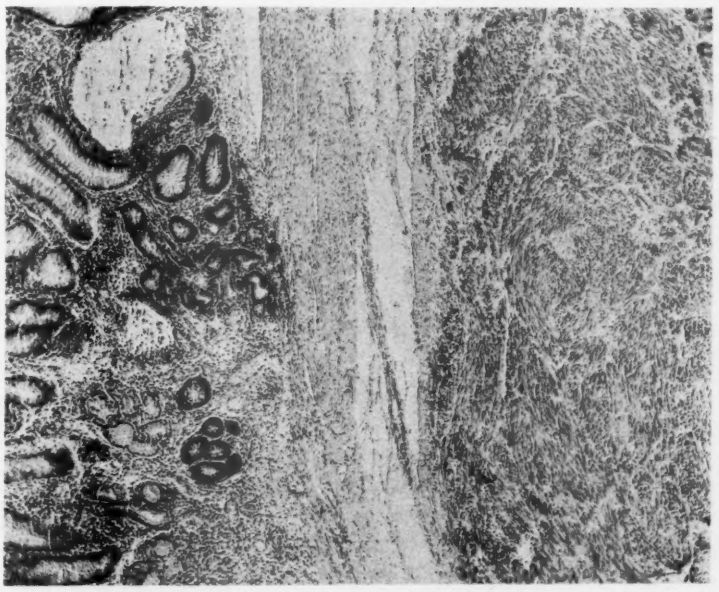

Fig. 8. Case 11. Showing the relations of the tumor to the gastric mucosa; low power 100 ×.

the pericardium contained a moderate amount of blood-tinged fluid. On sectioning, the myocardium the normal musculature was found tumor showed well defined mucosa, submucosa and muscularis mucosa. The tumor was apparently originating from the muscular layers. The

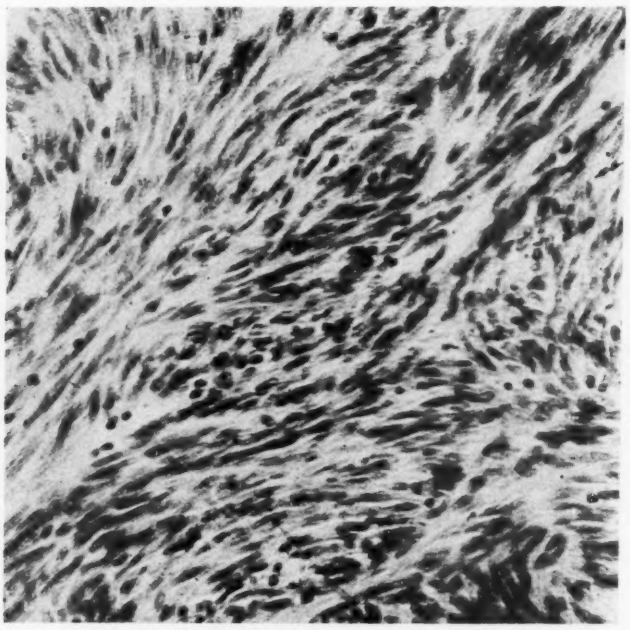

FIG. 9. Showing the tumor with well differentiated bundles of smooth muscle fibers forming whorls (leiomyoma); hematoxylin and eosin stain; high power 400 ×.

FIG. 10. Case III. Showing the resected stomach with extensive neoplasm.

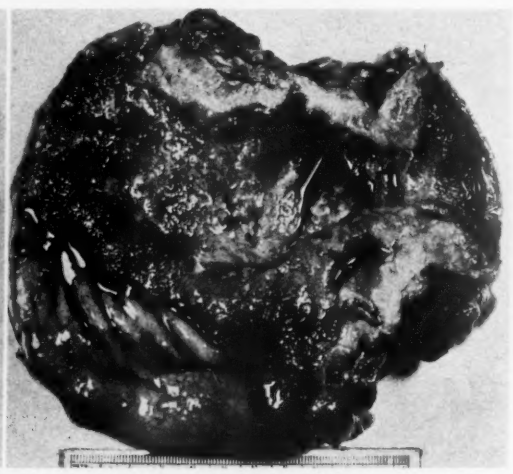

FIG. 11. Case III. Stomach opened. Infiltrating type of a tumor involving all the layers of the stomach.

partially replaced by a pinkish-grey, soft tumor mass protruding into the left ventricular chamber also invading the papillary muscles and chorda tendina of the mitral valve. The right side of the heart showed similar infiltration of the septum and the anterior wall of the right ventricle. The auricles, pulmonary and aortic valves were free from metastases. Microscopical study of the sections of the stomach cells were multiform, poorly differentiated and had hyperchromatic nuclei and numerous mitotic figures. The majority of the cells were spindle-shaped resembling that of smooth muscle cells; others were multinucleated and single nucleated giant cells.

Sections from the heart, lungs, and omentum showed identical tumor cells that were found in the original tumor of the stomach. The diag-

nosis was leiomyosarcoma of the stomach and duodenum with metastases to the heart, lung and the omentum.

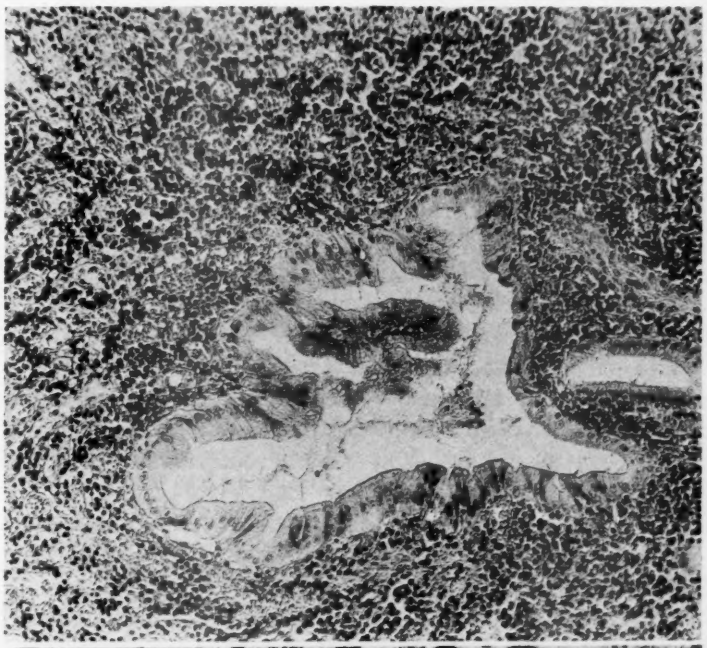

Fig. 12.

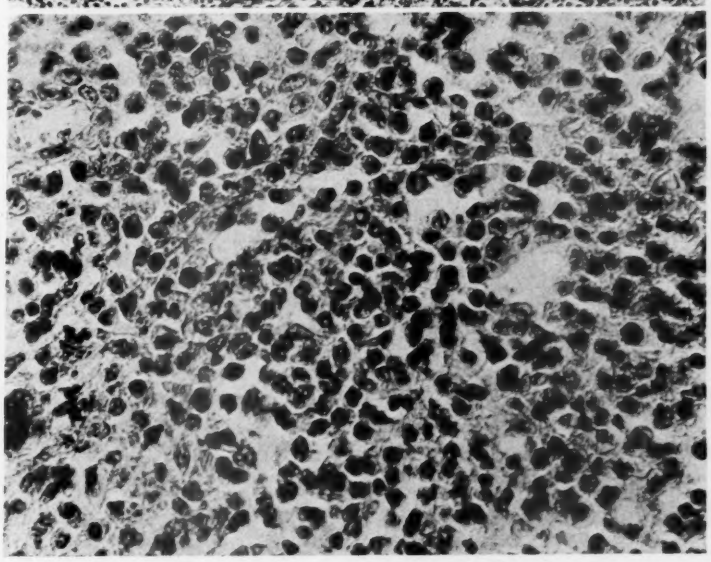

Fig. 13.

Fig. 12. Case III. Round cell type of sarcoma infiltrating the mucosa; note the glands intact; low power 100 ×.

Fig. 13. Case III. Note the type of cells generally uniform, hyperchromatic nuclei and mitosis is seen (lymphosarcoma reticulum type).

Case II. Mrs. G. R., aged seventy, para 16, was admitted to the hospital on August 31, 1940, complaining of midabdominal cramps and burning, profuse vomiting, weakness and anorexia. These symptoms began four weeks prior to admission and on one occasion emesis contained bright red blood. The epigastric pain had no characteristic radiation and was severe enough to keep the patient awake at night. Bowels which had been regular up to six weeks before, became constipated and daily enemas were productive of a dark black stool. The patient lost twenty pounds in six weeks and weakness became rather marked. No jaundice was noticed at any time.

The patient had attended the out-patient department since 1930 with similar complaints except for the absence of bloody vomitus and tarry stools. Physical examination at the time

was negative except for severe tenderness over the gallbladder region. The laboratory report showed hemoglobin 70 per cent; red blood count 4,100,000; white blood count 8,400; and urinalysis, Wassermann and Kahn tests were negative. Gastric analysis showed an achylia with a faint trace of blood. The gastrointestinal series and cholecystogram showed no lesion which could be a basis for symptoms. An abdominal support was prescribed for a pendulous abdomen and symptoms were relieved. Since the onset patient returned to the clinic about four to five times a year and presented various other complaints such as headache, nervousness and vertigo, none of which could be related to gastrointestinal system. There were intermittent recurrences of original complaints but these were of a mild nature. Diarrhea started about one year after her visit, alternated with constipation and at times was rather severe. For one year before the onset of present symptoms the patient felt fairly well. Other incidents in her postmedical history were tonsillectomy in 1916, thyroidectomy in 1917 and laparotomy in 1919 for some unknown reason.

Physical examination on admission showed deep tenderness over the epigastrium and to a lesser extent over left half of abdomen. No masses were palpable and peristalsis was active. Left lobe of thyroid was uniformly enlarged with no nodules present. Heart and lungs were negative. Blood pressure was 134/80. T.P.R. normal; hemoglobin 70 per cent; red blood count 4,380,000; white blood count 7,454; and urinalysis negative.

The gastrointestinal series showed a rather extensive filling defect of the middle and distal portion of stomach. *X*-ray diagnosis was that of a large neoplasm, probably carcinoma. The value of surgery was difficult to estimate due to extensive involvement but a laparotomy was decided upon for subtotal gasterectomy or palliative gastroenteromy. Eight days after admission during which time epigastric pain, anorexia, and severe tenderness continued, she developed a chill and ran a temperature of 101.2°C. Physical examination showed impaired breathing and *x*-ray showed a pneumonic process in lungs, temperature receded in three days and eleven days after pneumonitis.

The patient was operated upon. A large mass about the size of a baseball was felt within the stomach attached to the lesser curvature by a broad base causing an intussusception. Due to sudden increase in pulse rate of subtotal gastrectomy could not be performed and instead the tumor was excised from the stomach wall and the opening closed. No metastatic nodules could be found. Blood transfusion and intravenous glucose were given during operation.

Postoperative convalescence was entirely uneventful and the patient was discharged sixteen days after operation feeling fine.

The excised tumor measured 12 by 10 by 5 cm. One surface was covered by mucous membrane, the opposite side by a serous covering well encapsulated. There was an ulcer in the center of the mucous membrane with an inverted margin measuring 3 by 1 by 2 cm. On sectioning, it was firm and solid in consistency, friable and pinkish-grey in color.

Microsections of the tumor showed a well defined gastric mucosa. The glands were lined by high columnar epithelium and goblet cells. The muscularis mucosa showed definite demarcation from the tumor mass which occupied the muscular layer of the stomach. The muscle fibers ran in all directions. The cells were well differentiated and mature in type. They were uniform in size and staining characteristics. No evidence of malignant degeneration was present. Pathological diagnosis of leiomyoma of stomach was made.

Case III. A fifty-three year old white female was admitted to the service of Dr. H. Frankenstein, on October 2, 1939, complaining of abdominal pain for a period of six months. Most of her pain was in the epigastric area and radiated through her back. She also complained of anorexia, vomiting, constipation, black tarry stools and some dyspnea on exertion. There were no chills, fever or jaundice. She lost twenty-eight pounds in six weeks.

On examination the abdominal wall was flaccid and a mass was palpable in the right upper quadrant just below the right costal margin. It was fixed, nodular and adherent to the surrounding structures. The remainder of the physical examination was negative. T.P.R. are in normal limits.

The patient had several attacks of emesis all of which were coffee-ground in nature. The urine was negative, hemoglobin 49 per cent; red blood count 2,770,000; white blood count 6,650. The gastric contents were positive for occult blood and negative for free HCl. The Wassermann and Kahn tests were negative; blood sugar 95 and N.P.N. 29.

X-ray showed a defect at the pyloric end of the stomach. Following three transfusions a subtotal gastrectomy was performed on October 12. There were a few regional lymph nodes involved but the liver showed no metastases.

The resected portion of the stomach presented a large tumor mass of stony hardness involving the anterior surface and greater curvature of the stomach. It measured 9 by 9 by 4 cm. and on sectioning presented marked fibrosis. Near the distal portion was a papillary growth about 1.5 cm. in diameter which was markedly injected, soft and friable. Around this mass there were numerous small similar growths with ulceration. On sectioning, the mass was stony hard, gritty and showed some degeneration. Following the study of microscopic sections, the diagnosis of round cell sarcoma (lymphosarcoma) was made.

The immediate postoperative course was good. Temperature not going above 99.8°c. She received deep *x*-ray therapy to the gastric area on October 28, for thirty-five minutes, October 30, forty-one minutes and November 1, thirty-nine minutes. She improved and was discharged November 5, 1939.

The patient was readmitted on December 26, 1939 complaining of pernicious vomiting, weakness and pains in her back.

A gastroscopy showed the gastroenterostomy opening to be adequate. She continued to vomit persistently for days and expired on February 18, 1940. No permission was obtained for autopsy.

DISCUSSION

Myosarcomas of the stomach usually arise from the curvatures and often project into the peritoneum as solitary solid or cystic tumors and may attain an enormous size. The majority are single but occasionally they are multiple in origin as in our cases. They very seldom occur near the pylorus and obstruction is, therefore, uncommon.

Leiomyoma and leiomyosarcomas of the stomach have been divided into three types: the extragastric, the intragastric or submucosal and, thirdly, the infiltrating or mucosal variety. The extragastric is the type most frequently observed. They are generally well encapsulated, well outlined and circumscribed, giving the appearance of an innocent tumor. Metastases are not common. The mucosa is usually free from infiltrating tissue and can be easily shelled off, while in lymphomatous growths infiltration of the mucosa is fairly common. Ulceration and perforation throughout the mucosa occurs in many of the cases, causing the most common symptom—hemorrhage—with its resultant anemia. The margins of the ulcer are usually inverted in contrast to carcinomatous ulcers whose edges are everted. Various forms of degenerative changes with cyst formation frequently occur.

The histological structure of leiomyosarcoma varies: sometimes the cells are distinctly muscular in type; in other cases the predominant cell may be the large spindle variety, while in still *others* there is a mixture of both. Determination of the origin of the tumor depends upon the predominating cell type. At times this is fairly simple and definite, while at others it is doubtful because of the marked cellular anaplasia present.

In several cases on record, the tissue diagnosis was not conclusive, the opinions of various pathologists being widely divergent.

Some of the tumors were diagnosed as cellular carcinoma, but in subsequent examinations the diagnosis was changed to sarcoma. The consensus of opinion at this time is that most of the spindle cell tumors originate from the muscle layers of the stomach and that they are a well defined group resembling myosarcoma of the uterus. It is doubtful that all cases grouped as lymphosarcoma of the stomach actually originate primarily in the stomach. It is more reasonable to assume that some of these cases are simply a local manifestation of a general disease, such as Hodgkin's disease, or arise *secondarily* from a distant primary focus.

SUMMARY

1. Of all types of primary gastric tumors diagnosed histopathologically in this hospital within a period of ten years, there was a

total of 122. Five were nonepithelial tumors or a little over 4 per cent.

2. Three out of five are still living and well after surgical intervention, two for a five-year period and in one, over a year has elapsed since operation.

3. Two patients are dead, one with multiple leiomyosarcoma of the stomach and duodenum with metastasis to heart, lung and omentum. The second patient died of recurrent reticulum cell sarcoma of the stomach. No postmortem examination was available, therefore, no account of the extent of metastasis can be given.

4. In leiomyosarcoma of the stomach, when diagnosed early and before metastasis, total resection of the tumor with partial gastrectomy generally will give very good results.

5. Nonepithelial tumors can occasionally be diagnosed grossly but final diagnosis must rest on microscopical study of the cellular elements. At times even microscopical studies are not conclusive especially in borderline cases of cellular leiomyoma and sarcoma.

6. Surgery in lymphosarcomas usually is not as encouraging as in cases of leiomyosarcoma.

We extend our thanks to Drs. T. Schubb, H. Frankenstein and H. Loikrec for their permission to utilize the available material of their cases.

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PEPTIC ULCER AND GASTRODUODENAL FISTULAE*

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FISTULAE due to peptic ulceration are not uncommon. Most of them develop as complicating sequelae to surgical intervention in the treatment of chronic peptic ulcers. They are represented by the gastrojejunal or gastrojejunocolic fistulae. Corresponding to the increase of gastric surgery in the treatment of peptic ulcer, their number has increased manifold in the past three decades.

In contrast to the above, the occurrence of spontaneous gastric fistulae, on the basis of a peptic ulcer, seems to be rather uncommon. The literature contains only few references to fistulae between the stomach and other contiguous abdominal organs. Thus one finds only *isolated* reports of peptic ulcer causing fistulae into (a) the transverse colon, (b) the duodenum, (c) the ileum, (d) the jejunum, (e) the gallbladder, (f) the common bile duct, (g) the pancreatic duct, (h) the portal vein, (i) the renal pelvis, and (j) the spleen. A few instances of fistulae between the stomach and nonabdominal organs, as the heart (left ventricle), pericardium, lungs, pleural space, and skin, are also recorded.[1]

A perusal of the literature reveals that only very few cases of true gastroduodenal fistulae have been reported. Although met only infrequently, the awareness of such a condition is of obvious importance to those engaged in gastrointestinal practice. The following two cases are, therefore, reported:

CASE 1. J. C., male, aged forty-six, entered the medical services of the Cook County Hospital, complaining of intermittant abdominal pain of four years' duration, and a loss of 20 pounds during the previous three months. He was quite well until about one year before when he first developed a pain in the left upper quadrant which radiated to the back. This distress occurred within three hours after meals, was quite sharp and was relieved by any kind of food and by vomiting. Alkalis were not taken. The pain would cease spontaneously within one-half to one hour, but the evening pain usually persisted throughout the night, until he ate breakfast. There was no periodicity to the pain. In the past year the patient had vomited only four times and this had occurred at the height of the pain. No constipation or diarrhea has been associated with the condition. Lately anorexia, weakness and loss of weight became apparent. There were no other pertinent symptoms. His past and family history were irrelevant.

The physical examination revealed a fairly well developed and fairly nourished individual, who was apparently in distress. His temperature and respirations were within normal. The pulse was 96. The blood pressure, 120 systolic over 78 diastolic. Increasing breath sounds and a suggestive pleural friction were noted over the right pulmonary base posteriorly. The heart findings were within normal limits. The abdomen was slightly distended. There was a fullness in the epigastrium which seemed to move on respiration. Tenderness and resistance to palpation were present over that fullness. The liver was not felt. Other findings were essentially negative.

The laboratory examination disclosed a free acidity of 60 and 45, and a total of 80 and 60 degrees, respectively. There was no lactic acid. The stool showed no chemical blood. The Wassermann test was reported negative.

In view of the above history and findings, the diagnosis of a peptic ulcer was made, although a malignant growth of the stomach was strongly considered. The patient felt well on a modified Sippy regimen. An *x*-ray taken three days after entrance was reported as follows: "The pars media of the stomach act as a re-

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tention pocket holding the barium as long as 48 hours. The pyloric portion and duodenal bulb seem to open from the lesser curvature of the stomach high up as if the patient may have had a penetrating ulcer on the lesser curvature of the stomach which had perforated into the duodenum. The large pocket fills first and then the barium goes through the pylorus. There is an incisura opposite the duodenal bulb and there is a very definite fleck of barium, after 48 hours' examination." (Fig. 1.)

FIG. 1. Case I. *X*-ray showing tobacco pouch-like stomach with large gastric ulcer continuous with duodenum. A, gastric ulcer; B, duodenum.

Because of the unusual findings, the patient was transferred to a surgical ward for an exploratory operation, which was performed by Dr. K. A. Meyer. A large inflammatory mass was found along the lesser curvature of the stomach, which extended toward the antrum and first portion of the duodenum. A crater was palpated on the inner surface of the mass, which seemed to continue as a fistulous tract into the duodenum. The operation was terminated with a posterior gastroenterostomy.

The patient made an uneventful recovery and continued symptom-free on Sippy management. An *x*-ray taken four weeks after the operation showed: "Small retention. Gastroenterostomy functioning well. Moderate amount of barium goes through the region of the perforated ulcer." After discharge from the hospital, the patient was referred to the Gastrointestinal Clinic. There he reported at various intervals, always feeling fine and showing a gain in weight while on a Sippy regimen.

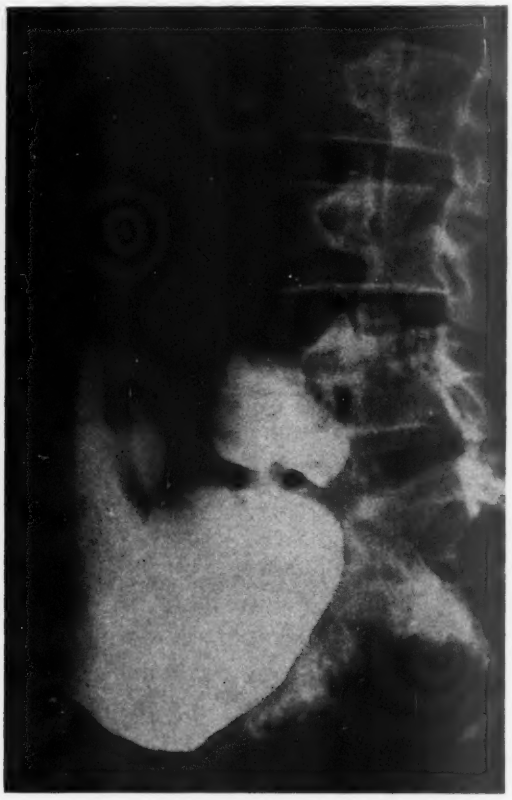

FIG. 2. Case II. *X*-ray of stomach showing large penetrating ulcer; fistulous communication not seen.

CASE II. R. G., a white, fifty-four year old male, entered the medical services of the Cook County Hospital, complaining of abdominal pain and loss of weight, of about two months' duration. He was apparently well until six months previously, when he first noted a postprandial fullness associated at times with abdominal distress. This continued for about three months, when he developed additional symptoms of anorexia and weak spells. This fullness was best relieved by induced emesis. About two months before, he experienced for the first time a lower abdominal pain which would occur two to three hours after meals. This pain, steady and burning, was relieved by vomiting, water and alkali, and aggravated by acidic foods. In the past few days, he had emeased a "coffee ground" material, and noted that his stools were black. He has lost weight progressively since the onset of the first symptoms, (a total of about 20 pounds in six months).

The only pertinent finding in his past history was the ancient occurrence of a "blind abscess" in the right lower portion of his abdomen which drained spontaneously through the rectum. There was no history suggestive of previous gastrointestinal disturbance. The patient smoked and drank moderately. The family history was irrelevant.

The physical examination revealed a well developed but poorly nourished individual, not acutely ill. His temperature was 98.4°F., pulse, 56, and blood pressure 144 systolic over 94 diastolic. The chest was phthisical with deep supra- and infraclavicular fossae. There was a bronchial type of breathing in both apical areas, especially in the right where a few clicking rales were heard. The heart was slightly enlarged and the tones were distant. The peripheral vessels were sclerotic. The abdomen was scaphoid and slightly rigid in the upper

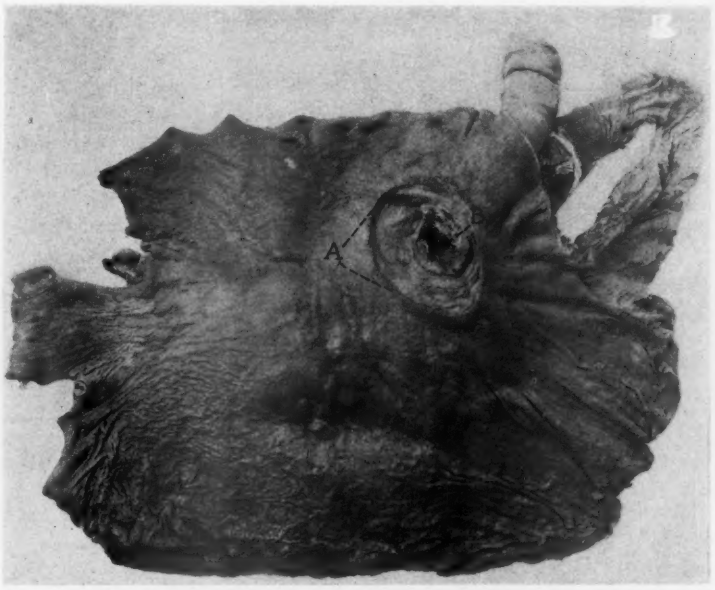

Fig. 3. Photograph of postmortem specimen of stomach showing large penetrating ulcer (A) and the stoma of the spontaneous perforation of the duodenum (fourth portion) (B).

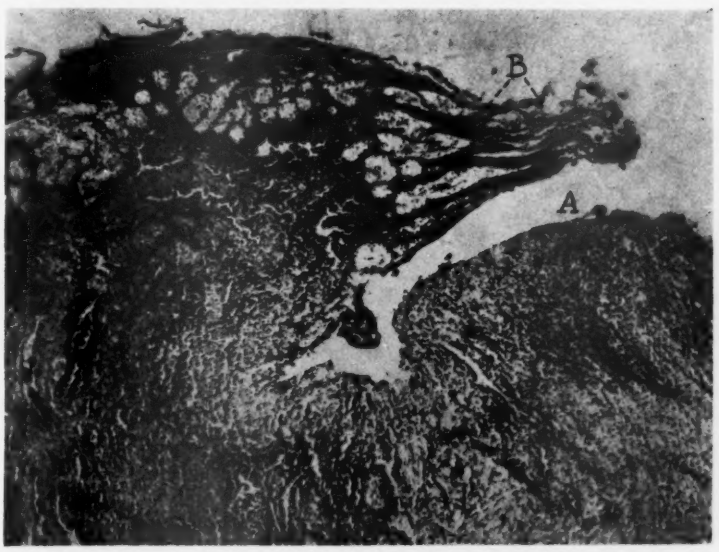

Fig. 4. Microphotograph of section from raised edge of the large gastric ulcer showing (A) floor of ulcer and (B) overhanging edge. No malignant changes noted.

quadrants. The liver and spleen were not enlarged. The extremities and the reflexes were within normal.

the stomach was considered the most probable diagnosis, although the possibility of a peptic ulcer was also entertained. The patient was put

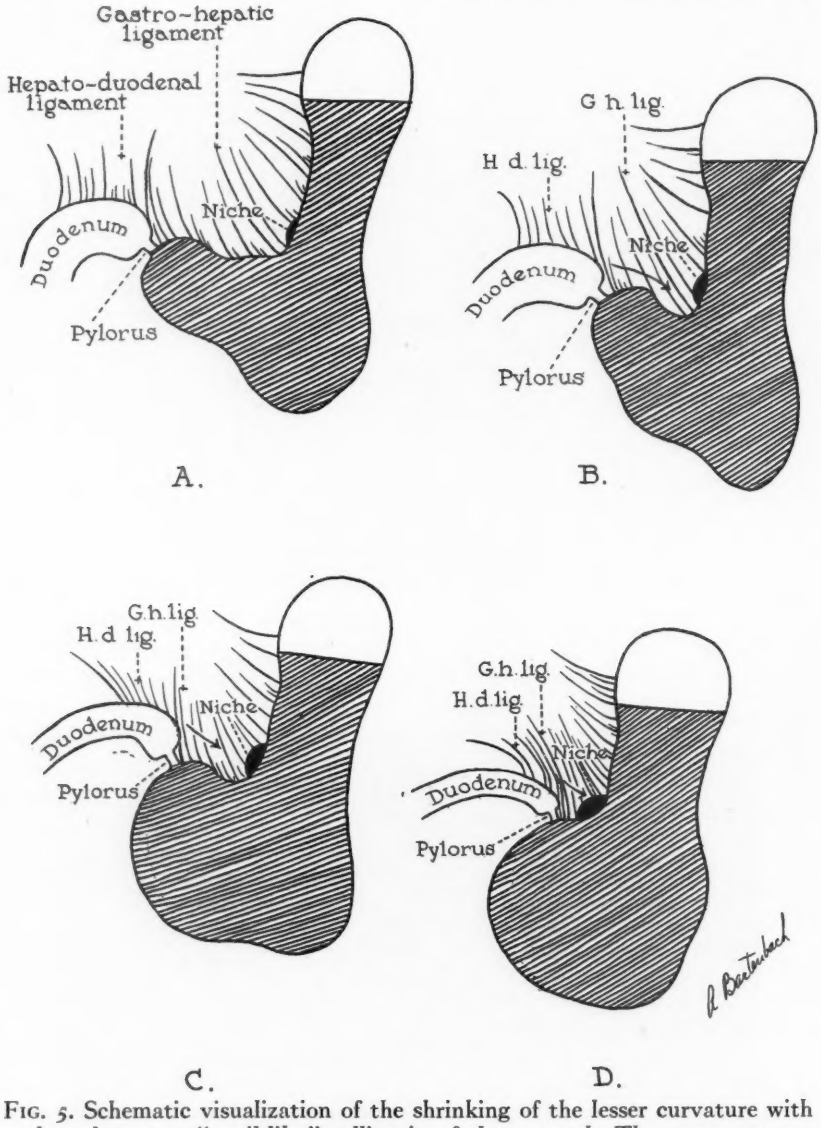

FIG. 5. Schematic visualization of the shrinking of the lesser curvature with the subsequent "snail-like" rolling in of the stomach. The arrows on B-D point to the shrunken area.

The laboratory workup disclosed persistent chemical blood in the stool, a free acidity of 40 degrees, a total of 58 degrees and no lactic acid. The hemoglobin was 80 per cent (Tallquist); the red blood count 5,150,000 and the white blood count, 15,500. (The comparatively high blood count was probably due to dehydration with hemoconcentration.) The urine examination was negative. An *x*-ray of the stomach showed a large constant niche on the lesser curvature of the pars media of the stomach. (Fig. 2.)

Because of the relatively short history, the patient's age and his cachexia, a carcinoma of

on sedatives, antispasmodics and the "creamalin drip" was instituted. In spite of careful and intensive management, including also intravenous fluids, the patient continued to go downhill, and expired five days after entrance to the hospital, shortly after a massive gastric hemorrhage.

At necropsy the main pathology was found in the abdominal cavity, which contained a small amount of a serosanguinous fluid. Several of the intestinal loops were adherent to each other by focal fibrous adhesions, and dense adhesions were formed between the posterior wall of the stomach and the neighboring viscera,

especially the distal third of the duodenum. The stomach and the intestines were markedly distended and contained a large amount of dark red liquid and coagulated blood. The mucosa of the stomach was injected, studded with many dark red pinpoint hemorrhagic areas, and was covered by a bloody mucoid material. The folds and rugae were fairly distinct. About 4½ cm. proximal to the pylorus and along the posterior aspect of the lesser curvature of the stomach was a large crater-like defect, 4 mm. in depth and 6 cm. in diameter, with moderately indurated and undermined edges. The base was grayish tan and 1 cm. from the edge proximal to the pylorus were three open-mouthed vessels up to 2 mm. in size, which were filled with loose, clotted blood. Near the center of the crater was a 3½ cm. defect through the muscularis and serosa of the stomach, which opened directly into the fourth portion of the duodenum, forming a natural gastroenterostomy stoma which was functioning both ways. The margin of the ulcer nearest the pylorus for a distance of 2 mm. was raised to a height of about 4 mm. and was about 4 mm. wide. (Fig. 3.) This area was slightly firmer than the rest of the rolled margin. Five mm. distal to the large defect of the mucosa was a 15 by 10 mm. defect, which was very superficial. The duodenum and first portion of the jejunum were congested and dark purple red. The pancreas was slightly adherent to the stomach near the gastroduodenostomy. Its consistency was slightly increased and it weighed 50 Gms. On sectioning, it was light tan and uniformly lobulated. There was also a Meckel's diverticulum which was 4 cm. in length.

There were no other pertinent findings in either the abdominal or chest cavities.

Microscopic section of the stomach through the ulcer showed the floor to consist of dense sclerosed connective tissue which had completely substituted the muscularis propria. On the surface, the connective tissue gradually passed over into a layer of fibrinoid necrosis, of cellular granulation tissue and of callous tissue. At the edge, the necrotic zone extended beyond the reflection into the proximal part of the overhanging portion The muscularis also extended into the overhanging portion. There were round cell infiltrations about some of the smaller vessels of the submucosa. The adjacent gastric mucosa was composed of tubular and slightly tortuous glands, between which were found several plasma cells and some polymorphonuclear leukocytes. There was no evidence of malignancy. (Fig. 4.)

SUMMARY AND CONCLUSIONS

Two cases of noncarcinomatous, true gastroduodenal fistulae are reported and their pathogenesis discussed.

Even though rare, such fistulae occur sufficiently often, as to make diagnosis difficult.

The awareness of such a condition is not only of diagnostic interest but also of practical importance to the surgeon, who otherwise when confronted with it at a laparotomy might easily diagnose it as a malignant, nonoperable mass.

To the internist and roentgenologist, the knowledge of such an affection may be of diagnostic aid in cases which present a peculiar abnormality in the gastroduodenal region.

Since there is no known way in which such a condition may be diagnosed clinically, the hope for a correct diagnosis rests unquestionably on the *x*-ray examination. In some cases, however, the last decision may have to be made by the surgeon.

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PHARYNGOESOPHAGEAL DIVERTICULUM

REPORT OF TWO PATIENTS TREATED SUCCESSFULLY BY A ONE-STAGE PROCEDURE

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MANY patients with pharyngoesophageal diverticula have been operated upon since the first successful case reported by Von Bergmann in 1892. While the condition is a relatively uncommon one, there have been in recent years many comprehensive reports in this country by Judd, Lahey, and Babcock and by Moynihan, Billet, Diez, Gerlings and Godard abroad. Herniations of the mucosa and submucosa represent a type of pulsion diverticulum. They differ from the traction type in that the latter contains all layers of the wall including the muscular layer. The traction type is more prevalent at the root of the lung where scar tissue from peribronchial lymph nodes exerts a pull on the coats of the esophagus. These traction diverticula rarely require surgical intervention. The pulsion type is usually found at the pharyngoesophageal junction posteriorly, where there is frequently a congenital weakness of the diagonal fibers of the inferior constrictor muscle of the pharynx as it meets the circular muscle of the esophagus. Most of these diverticula invariably present themselves toward the left side of the neck due to the proximity of the esophagus to that side at that level.

Pulsion diverticula may be relatively small but at times they reach considerable size. As their size increases, they gravitate along the vertebrae into the upper mediastinum between the pretracheal and prevertebral layers of fascia. They occur about four times more frequently in men than in women; moreover, they do not seem to attain similar magnitude in women as in men. They are rarely ever seen before the age of fifty although the history often suggests that they have been present for a considerable length of time.

Usually the patient does not seek surgical relief until a great deal of difficulty has been experienced in swallowing. Other symptoms as regurgitation of food, gurgling noises, or even choking spells may be prominent. The larger diverticula usually lead to inanition and dehydration since the enlarging sac encroaches upon the normal lumen of the esophagus causing distortion of the latter passage. This fact can be appreciated by those who have examined these individuals endoscopically in whom it becomes almost impossible to follow the esophageal lumen even under direct vision. We call attention here to the dangers of bougienage for diagnostic purposes and reserve this procedure for those cases which require it as a postoperative maneuver. Even here, perforation and resultant mediastinitis have been reported. We believe it advisable to have the patient swallow one end of a long silk thread some days before esophagoscopy. This string also facilitates introduction of a stomach tube for feeding purposes pre- or postoperatively.

There are many advocates of a routine two-stage operation but we are impressed with a like number of one-stage operators who have never had mediastinitis as a complication. After reviewing the results of

those with greatest experience, we have concurred with the opinions of Judd and Harrington who reserve the two-stage procedure for those cases: (1) in which diverticula are large, (2) in which considerable inflammatory reaction is found at operation on exposing the sac, (3) in which the patient does not represent a good surgical risk, and (4) in which the sac extends into the mediastinum.

Fig. 1. An oblique view of the partially filled diverticulum.

Fig. 2. Lateral view of the diverticulum. Note compression of the esophagus.

In the two-stage procedure the sac is dissected from its bed and is brought up to the skin and sutured to the sternomastoid muscle as a first stage. About a week or ten days later when the tissues of the neck have become sealed off and ligation of the neck of the sac and its removal are carried out, there is very little danger from cellulitis and mediastinitis. However, in certain instances in which operation upon the neck has been carried out before, the planes of the neck are already sealed off by scar tissue; consequently, this danger is eliminated.

In the individual in whom the diverticulum is small and the condition good, the operation can be carried out safely in a one-stage procedure. This has many advantages over the multiple-stage operation. First, hospitalization is shorter; second, recurrence and fistula formation are rare. Better visualization of the structures about the neck of the sac is provided when there is no scar from a previous stage. This permits a closer amputation of the sac and a better closure of the stump. Third, there is less danger of injury to the recurrent laryngeal nerve. Fourth, secondary bougienage is seldom necessary due to minimal distortion and spasm of the pharynx produced. Lastly, the so-called choking spells from trapping of air in a distorted anchored sac of a two-stage operation are eliminated. In cases in which fistulae have occurred following either procedure, these have usually closed spontaneously without difficulty.

Cervical block anesthesia is preferred, for the patient is able to swallow at all times; and if any fluid should be expressed from the sac, it would not be likely to get into the trachea. Cases of pulmonary abscess have been reported in which general anesthesia was used. Moreover, patients are always instructed to empty the sac before going to the operating room.

The operation consists of an incision about four inches long, anterior to, but parallel with the sternomastoid muscle.

In the two cases reported, the hospital time was materially cut down, and the patients made uneventful recoveries. There

Fig. 3. Lateral view of the filled diverticulum.

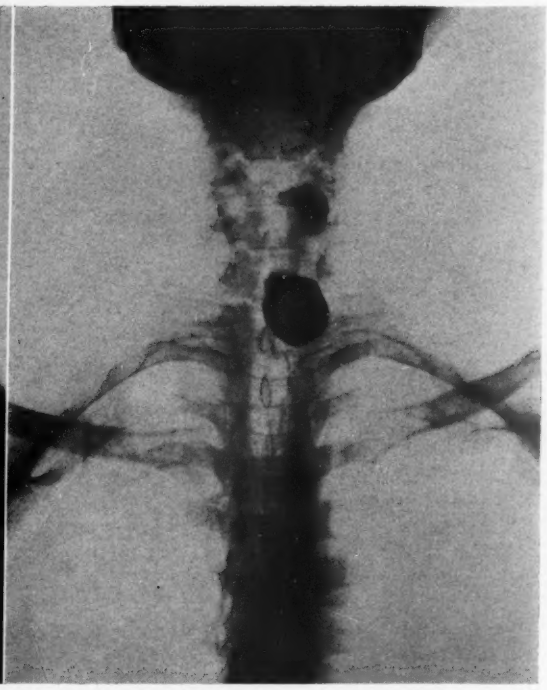

Fig. 4. Anterioposterior view of the diverticulum.

Dissection is carried down to the omohyoid muscle; this is divided. The carotid sheath is retracted laterally and the thyroid gland medially. The diverticulum will be found coming off from the posterior wall of the pharynx and can easily be identified by its lighter color; ordinarily there is a small plexus of veins over it. Getting the patient to talk or blow will also facilitate in locating the sac. As little circulation as possible is interfered with because of the inadequate blood supply to the structures. After the sac is freed up it is brought out through the upper angle of the incision, if it is of sufficient length; if not, it is stitched to the structures of the neck and can later be identified by leaving a silk thread sutured to the sac, if there is to be a two-stage procedure. If it is to be removed in one stage, the neck of the sac is ligated and then removed, a second row of inverting Lembert sutures being applied to the stump.

was a slight drainage of liquid food particles through the incision for a few days after the nasal tube was removed, which was done on the sixth postoperative day. It is advisable to leave the silk string down the esophagus into the stomach in case a change of nasal tube has to be done at any time, or if esophageal dilatations become necessary. The patient received nourishment through the nasal tube for the first week after the operation. By this procedure, tension on the esophagus is kept as slight as possible and healing proceeds rather rapidly.

Since so many of these patients are in the older group, we feel that it is advisable to let them get up on the day following operation. This will allow them to take care of themselves, particularly in regard to bladder elimination. The risk of the operation is very low when this plan is carried out. Following the operation the patient is able

to swallow normally, and usually begins almost immediately to put on weight.

Case I. Male, age fifty-five, had had trouble in swallowing for four or five years. He had been operated upon three times before, but recurrence followed promptly after each operation. On September 12, 1937, the patient was reoperated upon. The sac was found at its usual location. It was completely dissected and removed. The opening in the esophagus was closed by an inner row of silk. There was some drainage from the esophagus a few days after the operation but the fistula promptly closed. Since that time the patient has gained weight, has been perfectly well, without any difficulty in swallowing.

Case II. Female, age fifty-one, had had trouble in swallowing for three or four years. *X*-ray revealed pharyngoesophageal diverticulum. On June 17, 1939, the diverticulum was excised by a one-stage procedure. There was a slight liquid drainage from the esophagus about one week after operation. The patient had an uneventful convalescence. She has gained weight and has had no further difficulty with swallowing. Esophagoscopic examination reveals no stricture and there is no evidence of remaining diverticulum opening.

SUMMARY

We have presented two cases in which the one-stage procedure has been used in the treatment of pharyngoesophageal diverticulum. If the patient is in good condition and the sac is not too large, we believe that this procedure can be carried out. If there is any doubt as to the one- or two-stage procedure, we believe that the two-stage procedure should be used because there is less danger of mediastinal infection. The ultimate result should be obtained whether the one- or two-stage procedure is used. The one-stage procedure minimizes the amount of time, but time should never be considered if there is any question as to the safety of the patient.

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MERALGIA PARESTHETICA*

REPORT OF FIVE CASES

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MERALGIA paresthetica was first described in 1895 by Bernhardt. It was named the same year by Roth, from "meros" meaning thigh and "algos" meaning pain. The condition consists of a painful paresthesia of the anterolateral aspect of the thigh from the upper portion of the thigh to the knee, as outlined by the distribution of the lateral femoral cutaneous nerve. It is a relatively common condition and numerous authors have written on the subject. In spite of this, it is a condition which many physicians and surgeons still fail to recognize and treat properly. The orthopedist is not infrequently confronted with the condition.

The lateral femoral cutaneous nerve arises from the second and third lumbar posterior nerve roots and is primarily a sensory nerve, but Reichert[12] has shown that in addition to its somatic fibers, it also includes efferent sympathetic fibers carrying vasomotor, pilomotor and sudomotor impulses, and afferent sympathetic fibers carrying pain impulses. By anatomical dissections, Stookey[15] demonstrated an angulation of the nerve as it emerged from the pelvis just medial to the anterior superior iliac spine below Poupart's ligament. He found that it might pass superficial to, through or deep to the origin of the sartorius muscle, and that in some cases the never angulates more sharply by passing over a small bony ridge just below the anterior superior iliac spine. This angulation of the nerve is increased by extension and decreased by flexion of the thigh on the trunk, which explains why these patients usually have more pain when standing in the erect position.

As Bergsma[3] pointed out, meralgia paresthetica may be due to an irritation or degeneration of the nerve in its course through the thigh, or it may be simply a symptom complex which is part of a more widespread disease process involving other nerves in addition to the lateral femoral cutaneous nerve. The latter condition may be present in certain lesions of the spinal cord, the second and third lumbar vertebrae, and any intra-abdominal or intrapelvic lesions which cause pressure on the nerve during its course through the abdomen or pelvis. When a peripheral irritation or degeneration of the nerve is present, it is usually due to trauma. This trauma may be sudden and severe, as by a sharp blow or fall on the anterolateral aspect of the upper thigh region, or it may be the result of wearing a corset, brace, truss or belt which causes pressure. Cases have been recorded which followed occupational trauma such as constant leaning against a bench. In addition to trauma as an etiological factor, toxic, infectious and metabolic disturbances have been described by some observers.

A patient afflicted with meralgia paresthetica usually first notices a numbness and paresthesia of the area supplied by the lateral femoral cutaneous nerve. It is ordinarily intermittent in character and tends to become more annoying as time goes on, until finally it may become a moderate or severe burning type of pain which is ordinarily made worse by standing or walking. On examination, a tender point may be found medial to and below the anterior superior iliac spine where the nerve becomes superficial. Hypesthesia or hyperesthesia to touch, pin-prick, and

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temperature are found over the skin area supplied by the nerve; anesthesia has been noted in a few cases by some authors. The concentrically arranged deposits of connective tissue of a hyaline nature arising from growth of the endoneurium. Bailey[8] noted

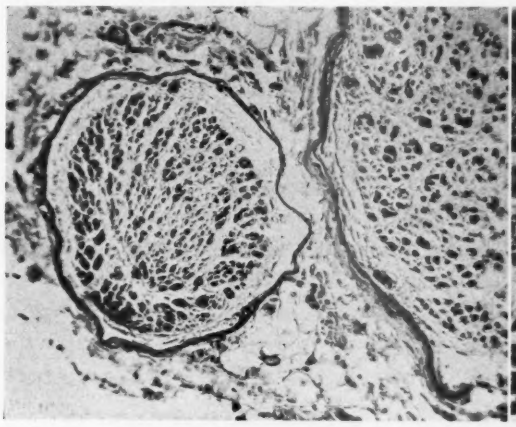

Fig. 1. Case v. Section of right lateral femoral cutaneous nerve. Note shrinkage and separation of nerve fibers. Axis cylinders are not discernible in places; hematoxylin and eosin stain. × 125.

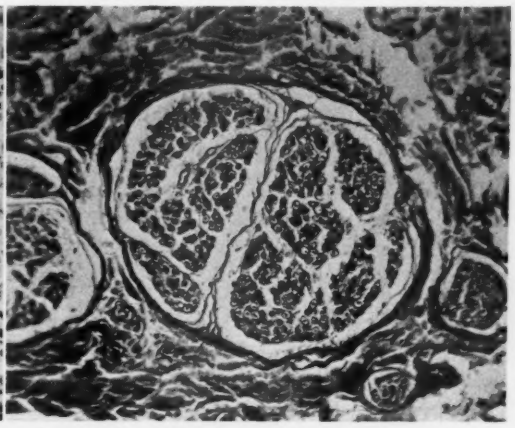

Fig. 2. Section of portion of normal nerve trunk (sciatic nerve) for comparison with Figure 1; hematoxylin and eosin stain. × 125.

condition is usually chronic, extending over a period of years.

Conservative treatment in the form of physical therapy and symptomatic medication may fail to give relief. Any offending corsets or braces should be adjusted to relieve pressure on the nerve, and any infectious, toxic or metabolic disturbances should be dealt with adequately. Intraspinal, vertebral, intra-abdominal or intrapelvic lesions should be ruled out or treated if present. If the condition is due to irritation or degeneration of the peripheral portion of the nerve, the most effective method of treatment consists in resection of a portion of the nerve in the upper thigh region. This procedure is recommended only when objective sensory changes are present. It is not advised when only a neuralgia with subjective symptoms alone is present, and should be done only when a thorough course of conservative treatment has failed to relieve symptoms.

At operation, Warda[8] noted a gross enlargement of the nerve trunk. Preti[8] observed ten cystic nodules on the nerve, while Chipault and Bellat[8] found a nerve full of varices. Haenel[1] described an extensive degeneration of the nerve upon microscopic examination with nodular and a microscopic fibrous thickening of the nerve sheath with degenerative changes in many of the fibers. Sougues and Andre-Thomas[8] found the nerve to be grossly and microscopically normal.

CASE REPORTS

Five patients with pain and demonstrable sensory changes involving the area supplied by the lateral femoral cutaneous nerve have been treated at the New York Orthopaedic Dispensary and Hospital by resection of a segment of the nerve in the upper thigh region beyond its emergence from the pelvis under Poupart's ligament. Twenty-one others responded to conservative therapy and were not treated surgically. They are not included in this report.

Case 1. G. A. H., female, aged thirty-two, had a pelvic laparotomy done in March, 1938, under spinal anesthesia for a retroverted uterus. Upon resuming walking several weeks later, she first noted a numbness, tingling and burning pain over the anterolateral aspect of the right thigh which became more constant and annoying as time went on. Examination revealed hypesthesia to pin-prick over the distribution of the right, lateral, femoral cutaneous nerve. On July 25, 1938, (four months after onset of

symptoms), under general anesthesia, the nerve was exposed in the upper thigh and one and one-quarter inches of it were resected. An Ober fasciotomy was also done because of a concurrent sciatic neuralgia. The section of nerve removed was grossly and microscopically normal. The patient experienced immediate relief of pain. Following operation, she noted a feeling of "deadness" over the involved skin area which disappeared after two months; a sensation of numbness persisted for an additional four months. On May 18, 1940, twenty-one months after operation, examination disclosed hypesthesia to pin-prick over the anterolateral aspect of the right thigh. Complete relief of pain had resulted.

Case II. M. S. K., female, aged twenty-nine, noted a gradual onset of numbness and paresthesia over the anterolateral aspect of the right thigh in 1924. No trauma was recalled. Numbness and tingling gradually became more severe and were replaced by burning pain which occurred several times monthly, lasting two or three days on each occasion. Symptoms were accentuated by prolonged standing and physical exertion. An area of hypesthesia was present over the distribution of the involved nerve. Pain was entirely relieved by 1 per cent novocaine injection of the nerve trunk just below and medial to the anterior superior iliac spine at its point of passage through the fascia lata. On October 29, 1938, (fourteen years after onset of symptoms), under local anesthesia, the nerve was exposed in the upper thigh and one inch of it excised. Grossly and microscopically the nerve was normal. A feeling of "heaviness" and "deadness" over the involved area disappeared two and one-half months after operation, giving way to a sensation of numbness which persisted for an additional three and one-half months. Pain was immediately relieved. On May 20, 1940, nineteen months after operation, examination disclosed hypesthesia over the anterolateral aspect of the right thigh. There had been no recurrence of pain.

Case III. E. L., female, aged nineteen, was born with a congenital dislocation of both hips. Shelf stabilization of the left hip was done in 1935, and a similar procedure was done for the right hip in 1936. Onset of intermittent numbness and pain over the anterolateral aspect of the left thigh was first noticed in December, 1938. This was experienced when walking and was relieved by sitting or lying down. The patient found it necessary to rest after walking two city blocks. Examination revealed hypesthesia over the distribution of the involved nerve. Pain was relieved by 1 per cent novocaine injection of the nerve. On May 29, 1939, (six months after onset of symptoms), under general anesthesia, the nerve was exposed in the upper thigh and one inch of it was excised. The nerve was grossly and microscopically normal. The patient was immediately relieved of her thigh pain. A sensation of numbness was experienced for several months after operation. On May 8, 1940, twelve months after operation, examination revealed hypesthesia over the involved area. No pain was experienced about the anterolateral aspect of the left thigh.

Case IV. G. B. H., female, aged twenty-five, was struck while crossing the street on May 15, 1939, on the upper and outer aspect of the left thigh by an automobile. Following the accident, she complained of numbness and aching pain over the distribution of the involved nerve. The pain was made worse by standing and was relieved by flexion of the thigh on the trunk. Hypesthesia was present over the anterolateral aspect of the left thigh. On July 19, 1939, (two months after onset of symptoms), under local anesthesia, the nerve was isolated in the upper thigh and one inch of it was resected. The proximal end was injected with 95 per cent alcohol. The nerve was grossly and microscopically normal. Immediate relief of pain followed operation. A feeling of "stiffness" of the involved region disappeared three months after resection of the nerve. Four months after operation, the patient received a second degree burn of the hypesthetic lateral aspect of the left thigh by leaning against a stove. The burned area, three-quarters inch by one-half inch in size, healed normally. On May 22, 1940, ten months after operation, examination disclosed hypesthesia of the area supplied by the left lateral femoral cutaneous nerve. No pain was experienced in this region.

Case V. P. W., male, aged fifty-one, experienced a gradual onset of numbness and tingling along the anterolateral aspect of the right thigh from the trochanteric region to just above the knee. It gradually became more annoying and painful. It ached constantly when he was standing and was relieved by sitting or lying down. His occupation (elevator operator) necessitated his standing continuously for long

periods of time. No trauma was recalled. Hypesthesia was present over the distribution of the right, lateral, femoral cutaneous nerve. On November 15, 1939, (three and one-half months after onset of symptoms), the right, lateral, femoral cutaneous nerve was isolated, under general anesthesia. A one-half inch section of the nerve was excised, and the proximal cut end was injected with 95 per cent alcohol. Immediate relief of pain was experienced. The nerve had appeared normal grossly but was markedly degenerated microscopically. This patient had consumed varying amounts of alcohol for a long period of time. A sensation of "deadness" of the anterolateral aspect of the right thigh persisted for two months after operation. On May 24, 1940, six months following nerve resection, slight numbness was still experienced, and hypesthesia to pin-prick was present over the lower two-thirds of the involved area. Pain was absent. The patient was standing eight hours a day.

DISCUSSION

Most authors[1,11] state that meralgia paresthetica is more common in males who are ordinarily obese, and in the fourth or fifth decades of life. Four of these cases herewith reported were females. None of them was obese, and their ages at operation were nineteen, twenty-five, twenty-nine and thirty-two years, respectively. The single male patient was fifty-one years of age and was not obese. There was a history of trauma preceding the onset of symptoms in three patients. All five noted an accentuation of symptoms when standing and walking. The condition was unilateral in each instance. Conservative treatment, in the form of heat and massage, proved to be of no value in each case. No gross or microscopic abnormality was found in the resected nerve segment in four of these cases. The fifth patient, who gave a history of chronic alcoholism, revealed no apparent gross pathology of the nerve but microscopically marked degeneration was seen. The axis cylinders could not be identified and the nerve fibers were reduced to nucleated neurolemma cells. The nerve fibers were shrunken and separated with considerable interstitial edema. The Masson-Foot stain revealed only six myelin sheaths in the entire section. The Loyez myelin sheath stain showed myelin to be absent except for a few nerve fibers where the pattern was atypical.

After operation patients should be warned of the danger of burning or otherwise injuring the anesthetic area over the anterolateral aspect of the thigh for a period of six months. Two or three months after operation sensation begins to return as a result of "overlap" from adjacent sensory nerves, and the anesthetic area becomes an area of hypesthesia.

SUMMARY AND CONCLUSIONS

Resection of a segment of the lateral femoral cutaneous nerve in the upper thigh as it pierces the fascia lata to become superficial, is the simplest and most satisfactory way to treat meralgia paresthetica which has proved resistant to conservative therapy. It should be done only when objective signs of peripheral nerve irritation or degeneration (hypesthesia or hyperesthesia over involved skin area, or tenderness to pressure over nerve at point where it becomes superficial) are present. Novocaine injection of the nerve trunk in the upper thigh, with resultant relief of pain, is a helpful diagnostic aid. Operation can be done under local anesthesia and segments of both the anterior and posterior branches should be resected. Absolute alcohol can be injected into the cut nerve ends to prevent neuroma formation. A feeling of "stiffness" or "deadness" of the anterolateral aspect of the thigh is complained of after operation, but disappears after two or three months as "overlap" from adjacent sensory nerves occurs. A sensation of numbness of the involved area persists for about six months following operation.

Meralgia paresthetica is in all probability due to an irritation or degeneration of the peripheral portion of the lateral, femoral cutaneous nerve. Microscopic examination of nerve segments removed in the five cases

herewith reported, as well as in those cases reported by other observers[1,8] in the past, failed to show any evidence of inflammation.

Five patients have been treated at the New York Orthopaedic Dispensary and Hospital by resection of a segment of the nerve in the upper thigh. They have been examined six, ten, twelve, nineteen and twenty-one months, respectively, following operation. Pain has been completely relieved in each case. Prior to operation, each of the five cases presented demonstrable sensory changes in addition to pain over the area supplied by the lateral femoral cutaneous nerve.

Operation is not advised in those cases presenting solely a peripheral neuralgia, as it is believed that the great majority of the latter are relieved by conservative treatment.

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INCIDENTAL INTRA-ABDOMINAL HERNIA REPAIR

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SINCE approximately 11.7 per cent of laborers (railroad employees)[1] as well as 2 per cent of women and 6 per cent of men,[2] totalling about 4,000,000 people in this country,[3] are estimated to have hernias, patients requiring an abdominal operation may also have an inguinal or femoral hernia. LaRoque[4] found abdominal hernia in 4 per cent of nearly 2,000 patients operated on for appendicitis and in 3 per cent of 1,500 to 2,000 women operated on for pelvic disease.

Repair of an inguinal or femoral hernia at the time of a lower abdominal operation might unduly increase the risk of operation. Under such conditions the hernial sac can usually be removed from within the abdomen without increasing the operative hazard, provided no suppuration is present. While the removal of a hernial sac alone is usually adequate for children and has been recommended for adults,[5] this method is advocated only for those patients who during the course of a laparotomy may not tolerate a supplementary repair of the inguinal or femoral regions and yet will not be jeopardized by the additional removal of the sac.

The intra-abdominal removal of a hernial sac without abdominal repair can result in a permanent cure. Even if the result should be temporary, excision of the sac as an incidental procedure is justified since it involves so little time and risk. It will permit the patient to convalesce from the abdominal operation without the discomfort usual to a hernia and without the danger of strangulation. Moreover, even with abdominal repair, from 5 to 10 per cent of indirect and 10 to 20 per cent of direct inguinal hernias recur.[1] Banerjee[5] prefers to repair all inguinal hernias intra-abdominally, and of sixty-six patients so treated, including three for recurrent hernias, the results were satisfactory over a period of six months to three and one-half years. In inguinal hernias repaired by this method as an incidental procedure, the longest period of observation without return of the hernia was five and one-half years, the shortest interval, fourteen months. One patient with an inguinal hernia had no evidence of recurrence for eighteen months, but at the end of twenty-four months examination disclosed that the hernia was again present. In a femoral hernia which recurred promptly following two previous hernioplasties, no evidence of recurrence has appeared for nine months since the intra-abdominal repair.

While the Trendelenburg position facilitates the removal of the sac, it is not essential. The bladder should be empty. Any omentum or intestine within the sac should be reduced. An incision is made around the internal ring, the edges of the sac are seized with forceps and by careful dissection the sac is separated from the cord or round ligament and other adherent structures. If the sac is so large that dissection promises to be difficult and tedious, part of the sac can be left behind without complications.[1] The peritoneum is then approximated over the denuded area and any redundant peritoneum may be overlapped and approximated.

CASE REPORTS

CASE 1. C. B., aged 33, a jewelry salesman, was seen on November 10, 1935, because of repeated attacks of subacute appendicitis of six months' duration. Fluoroscopic examination following the last attack confirmed the clinical diagnosis. Examination also revealed a right inguinal hernia of which the patient was un-

aware. On November 17, 1933, under gas-ether anesthesia an adherent, thickened, injected, and retrocecal appendix was removed by way of a low, right rectus muscle retracting incision. Because of the patient's request that the hernia be repaired through the abdominal incision, a moderate sized hernial sac in the right inguinal region was also excised. In April 1939, five and one-half years after the operation, there was no evidence of return of the hernia.

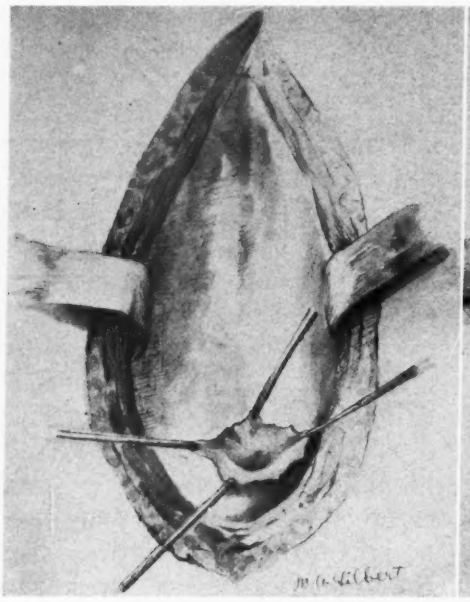

FIG. 1. Beginning dissection of hernial sac following incision around internal ring.

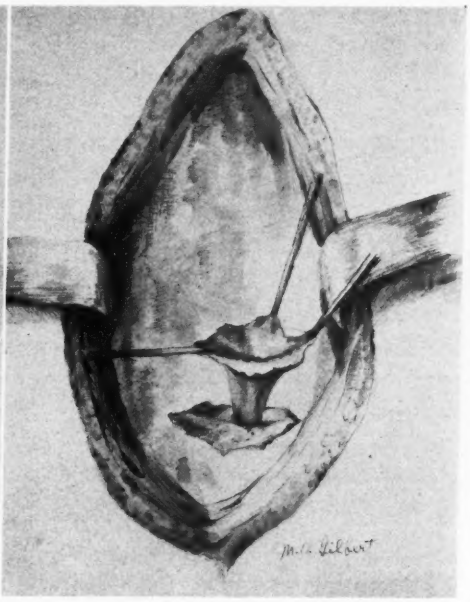

FIG. 2. Dissection of sac almost completed.

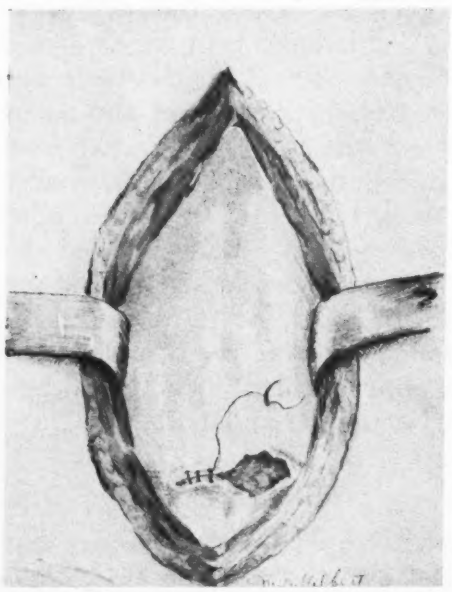

FIG. 3. Approximation of peritoneum.

CASE II. S. G., aged 45, a coppersmith, was seen on November 1, 1938, because of an attack of acute appendicitis. Examination also disclosed a right inguinal hernia; this was of one and one-half years' duration. Under spinal anesthesia and through a low, right rectus muscle retracting incision the appendix, which was acutely inflamed but not ruptured, was removed. Because the patient was stout and had a thick-walled, pendulous abdomen, and because an additional hernia operation at this time was deemed inadvisable, the hernial sac, which measured 3 inches in length, was removed intra-abdominally. Fourteen months later there was no evidence of hernia.

CASE III. A. F., aged 50, a housewife, was seen on March 4, 1939, because of symptoms due to uterine fibroids. Two operations within the previous four years for the repair of a left femoral hernia were followed by prompt recurrence. On March 5, 1939, under spinal anesthesia and through a median hypogastric incision a supracervical hysterectomy, bilateral salpingo-oöphorectomy, and appendectomy were done. The extent of the operation warranted no supplementary incision for the repair of the hernia; therefore, the sac, which measured 1½ inches in length, was removed through the celiotomy wound. Nine months after the operation the result was still satisfactory.

CASE IV. M. S., aged 55, a retired grocer, was seen on April 19, 1932, because of an attack of acute appendicitis. He also had a right inguinal hernia of two years' duration. Under

spinal anesthesia a low, right rectus muscle retracting incision was made, and an acutely inflamed, unruptured appendix was removed. An additional hernioplasty at this time was considered ill-advised; therefore, an incision was made around the hernial ring, and the peritoneum approximated over the denuded area, but the sac was not excised. In September, 1939, seven and one-half years later, the abdominal wound was firm but an inguinal hernia was again present. The patient first noted recurrence about two years after the operation.

Case v. C. S., aged 46, a housewife, complained of menorrhagia and a left inguinal hernia. Examination also showed many fibroids of the uterus. On August 15, 1935, under gas-ether anesthesia and through a median line incision a supracervical hysterectomy and bilateral salpingo-oöphorectomy were done. Because this was a difficult operation, an additional hernioplasty was contraindicated. The sac of the hernia, which measured about 2 inches in length, was removed through the abdominal incision. Eighteen months after operation there was no evidence of recurrence, but at examination six months later the hernia was again present.

SUMMARY

1. The intra-abdominal repair of a femoral or inguinal hernia is advocated for those patients who might be jeopardized by a supplementary hernioplasty at the time of an abdominal operation.

2. Several cases are presented illustrating various end results over a period of nine months to five and one-half years following this method of treatment.

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UPPER ARM BIRTH PALSY ASSOCIATED WITH CONGENITAL TORTICOLLIS*

CASE REPORT

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THE two conditions as observed in this case are occasionally associated. Their simultaneous occurrence has been reported and described although not frequently. One can readily realize the possibility of trauma during a difficult delivery, tearing or stretching the sternocleidomastoid muscle as well as parts of the brachial plexus. Apparently in this patient those nerve branches supplying the external rotators of the shoulder alone were damaged. The remaining musculature of the upper extremity was unaffected.

Besides correcting the deformities of wry neck and internal rotation contracture of the shoulder, it was decided to alter the imbalance between the paralyzed external rotators and the functioning and already contracted internal rotators. This was attempted by employing a procedure which has been described by L'Episcopo.[1] Briefly, this consists of a section of the tight internal rotators and adductors, namely, the pectoralis major, subscapularis, latissimus dorsi and teres major (Sever operation). Then the latissimus dorsi and teres major through their conjoined tendon are carried around the back of the humerus and are transplanted on its lateral aspect as far forward as possible. This changes their direction of pull so that they are converted into external rotators. Thus the main factor for recurrence of deformity is removed. This procedure was performed prior to correction of the torticollis as it was believed that the patient would have more time for muscle re-education. The possibility of less functional improvement with advancing age, if the patient waited, was also kept in mind.

CASE REPORT

The patient, a well developed and well nourished female, fourteen years of age, was first admitted to the hospital on August 24, 1938. She complained of deformity of the neck and disability of her left upper extremity. These conditions had been present since birth and she had attended clinics previously where she had been advised operative correction but had not received treatment. Her general medical condition was good. She demonstrated no physical defects other than of the face, neck and left upper extremity. Her head was tilted to the left so that the occiput was approximated to her left shoulder and the chin pointed up and to the right. This attitude was fixed by a definite contracture of the sternal and clavicular fibers of the left sternocleidomastoid muscle and the platysma. There was a flattening of the left side of the face but no other gross disfigurement. All motions of the cervical spine were free except for some restriction on tensing the shortened sternocleidomastoid muscle.

Her left upper extremity was maintained in an attitude of marked internal rotation and adduction. The left arm was moderately smaller in circumference than the right. Otherwise the left upper extremity did not vary from normal in appearance, function or length. External rotation was greatly restricted both actively and passively. She was barely able to raise her hand to her mouth. The pectoralis major, the internal rotators of the shoulder and the soft tissues of the anterior part of the shoulder were severely contracted. On attempting to abduct she was able only to bring the arm upward and forward instead of laterally from the trunk so that the posterior and lateral fibers of the

* Presented at Bellevue Hospital Clinical Orthopedic Conference March 8, 1940. Service of Dr. Arthur Krida.

deltoid were not active. The teres major and latissimus dorsi functioned well.

X-rays of her cervical spine and left shoulder showed no defects; blood count and urinalysis were normal; and it was decided to perform operative correction of the upper arm birth palsy and congenital torticollis.

On August 31, 1938, under general anesthesia, the muscle transplant procedure was performed. The pectoralis major, teres major and latissimus dorsi were sectioned through a four inch incision along the anterior border of the deltoid. Then an incision was made along the posterior border of the deltoid. The conjoined tendon of the teres major and latissimus dorsi was identified medial to the long head of the triceps. This tendon was pulled posteriorly and passed under the long head of the triceps. The arm was externally rotated as far as possible and a thin osteoperiosteal flap was lifted from the lateral aspect of the upper third of the humerus. The tendon of the transplanted muscles was sutured here. A plaster shoulder spica was then applied with the arm abducted to 70 degrees and externally rotated.

After seven weeks the top of the cast was bivalved and removed daily to allow gentle rotation and abduction exercises. Due to the great amount of tension on the skin, the edges of the anterior wound pulled apart and gradually granulated in. The cast was removed entirely at the end of ten weeks at which time the patient had regained considerable deltoid power. She then started physiotherapy, active exercises and occupational therapy to help increase function.

On her second admission to the hospital fourteen months after the muscle transplant, the patient showed a definite release of her internal rotation contracture. She was able to abduct well, the arm going directly outward and upward away from the trunk. She was also able to bring the hand behind the head though this was not entirely due to action of the transplanted muscles in their new function. The patient stated that she was satisfied with the appearance and function of her left upper extremity.

On November 2, 1939, a wide section of the left sternocleidomastoid muscle was done and a head and body plaster applied with the head in an overcorrected position. The wound had been sutured with a dermal subcuticular stitch and the cast was removed after six weeks. She was discharged to the out-patient department and physiotherapy and stretchings were instituted.

The patient was last seen on February 20, 1940. She presented a good cosmetic correction of her previous torticollis deformity. She has maintained a free range of active and passive shoulder motion but very little active external rotation. This is probably due to lack of use of the arm during immobilization following her second operation. She is again being given physiotherapy and occupational therapy and has been encouraged to use her left upper extremity in her daily tasks. The patient is satisfied with the results of both operations but it is hoped that she may regain some active external rotation as time goes on.

SUMMARY

1. A case of co-existing upper arm birth paralysis and congenital torticollis has been described. Although the possibility of this combination of deformities is mentioned in standard textbooks, a search of the literature has failed to reveal reports of such cases.

2. In this instance treatment for these conditions has been attempted at a rather late stage.

3. The cosmetic result following the torticollis operation has been very satisfactory.

4. Passive release of internal rotation contracture of the shoulder and freedom of abduction of the arm have been attained by means of section and transplantation of the internal rotators of the shoulder. This latter result has been maintained for almost two years.

5. It is hoped that use of the arm will improve active external rotation.

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TUBO-OVARIAN CYST CAUSING SEPSIS AND THROMBOPHLEBITIS

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THIS case of tubo-ovarian cyst is of particular interest because of the atypical and confusing clinical picture which developed from venous obstruction produced by a large infected tubo-ovarian cyst. Rarely in the practice of gynecology is widespread edema of the lower extremities observed, due to pelvic pressure, and certainly with greater infrequency do we encounter the clinical picture of sepsis or thrombophlebitis incidental to infection in an ovarian cyst.

The clinical course and pathologic evidence observed at operation, however, explained satisfactorily how the above picture was produced.

History. For five days before admission to the gynecologic service a 35 year old colored housewife, married for ten years, was confined to bed because of a sudden swelling of the entire left lower extremity. She had fever but no chills and mentioned that for the last six months there had been painless progressive swelling of her abdomen and also a generalized weakness and fatigability.

Her menstrual history was normal (14 × 30 × 7). The flow was always moderate except for clots during the past three years. A mild dysmenorrhea, principally premenstrual, was also mentioned. The patient was sterile although contraception had never been practiced.

Physical Findings. On admission the patient appeared to be acutely ill and somewhat uncommunicative because of her stuporous condition. Her temperature was 101 degrees and the pulse and respiration slightly increased. The abdomen was enlarged to the size of a full term pregnancy by an ovoid non-tender cystic swelling which was fairly well outlined and which seemed to arise from the pelvis. The entire left lower extremity was approximately two and one-half times normal size, due to a marked pitting edema delimited proximally by Poupart's ligament. While the joints were mobile and painless, the internal saphenous vein area of the thigh was slightly but definitely tender on pressure.

Pelvic examination revealed a nulliparous introitus and moderate edema of the left labia majus. The cervix was short; the anterior lip was hyperplastic and the external os was pin point. Pressure on the abdominal mass was not communicated to the cervix and conversely, cervical movement could not be transmitted to the abdominal mass. Both fornices were free and not tender. The left fornix was slightly lower than the right. The left sacro-uterine ligament area was infiltrated by a cord-like, slightly tender structure, the interpretation of which was obscure. A brownish cervical discharge indicated the cessation of the last period. Rectal examinations did not yield any additional information.

The intern's diagnosis at admission was ovarian tumor with left pelvic thrombophlebitis and edema of the left lower extremity.

Laboratory Findings. The blood count on the day of admission showed a marked anemia and leucocytosis: hemoglobin, 43 per cent; red blood cells, 2,730,000; white blood cells, 37,600; band neutrophiles, 22 per cent; segmented neutrophiles, 64 per cent; eosinophiles, 2 per cent; lymphocytes, 7 per cent; monocytes, 2 per cent, myelocytes, 2 per cent; metamyelocytes 1 per cent.

A markedly active infection was also indicated by the Cutler blood sedimentation test, the index of which was 37 mm. in sixty minutes. Both Wassermann and urine tests were negative. A roentgenogram of the abdomen revealed on the flat plate "an intraperitoneal mass, most likely an ovarian cyst."

The diagnosis made by the gynecologic staff was essentially the same as that of our intern, except for the modification of ovarian torsion with secondary intracystic infection, and also

thrombophlebitis and possible sepsis, which were added after a twenty-four hour observation.

Repeated sedimentation tests and blood counts (Table I) indicated a persistent infection, although the blood culture after a two-day incubation period revealed no growth of any organism. In addition the temperature became septic, ranging between 101° and 104°F.

TABLE I
REPEATED BLOOD PICTURES

	11/14/39	11/16/39	11/17/39	11/19/39
Hemoglobin	43%	46%	45%	43%
Red blood cells	2,730,000	2,370,000	2,970,000	3,100,000
White blood cells	37,000	27,000	9,750	23,400
Band neutrophiles	12	22	17	18
Segmented neutrophiles	76	57	67	72
Eosinophiles	2	2		
Lymphocytes	8	15	12	8
Monocytes	2	4	4	2

Inasmuch as the patient was deathly sick, our opinion as to immediate treatment was conservative. Operation on admission and during the following few days was definitely contraindicated, not only because of the presence of local infection, but also on the basis of thrombophlebitis and the clinical picture of sepsis. While the surgical consultant suggested exploratory laparotomy at the time, medical and urologic opinions were similar to our own.

The following supportive treatments were therefore instituted: the edematous lower extremity was elevated and placed in a heat cradle. Daily measurements of the member indicated an increase in the swelling of the lower extremity (Table II.)

TABLE II
LEFT LOWER EXTREMITY MEASUREMENTS

	11/15	11/16	11/18	11/21	11/24
Upper left thigh	25.75	26.	26. Operation	26.	25.
Lower left thigh	17.5	17.5	16.25	17.5	16.5
Below knee	15.75	15.5	15.5	15.75	14.
Above knee	10.6	9.75	9.25	10.	8.7
Foot	10.45	10.75	10.25	10.	9.5

Sulfanilimide therapy (120 grains daily) was begun the day after admission and continued for six days, but in the absence of any clinical improvement this was discontinued, when the blood determination reached 15.1 mg. per cent in the blood plasma. The patient was given a transfusion on account of the marked secondary anemia.

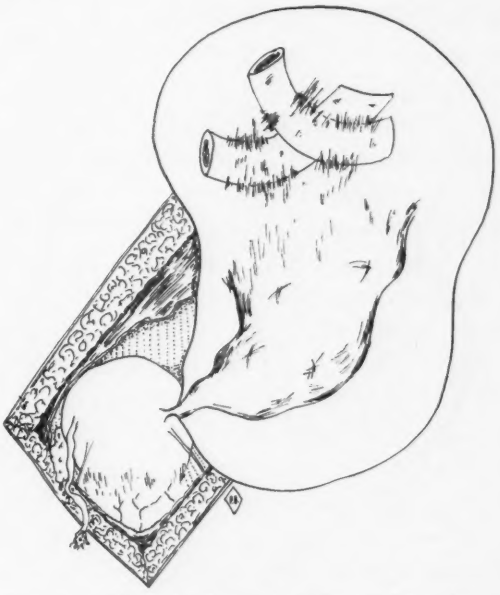

FIG. 1. Sketch showing large left tubo-ovarian infected cyst with small bowel adhesion.

Observation for one week under palliative and expectant measures revealed that the patient was becoming more toxic, as evidenced by a profound cloudiness of the sensorium, increase of leucocytosis and fever, and by the advance of edema beyond the inguinal ligament into the lower left anterior and posterior abdominal wall regions.

Thus after six days of downhill course with conservative treatment, further temporizing was considered inadvisable, since the patient was steadily approaching an agonal state. For this reason there seemed to be nothing to lose by an exploratory operation. The prognosis appeared to be thoroughly hopeless with or without surgery. Laparotomy was immediately performed under avertin and local novocaine block anesthesia.

Operation and Findings. Upon opening the abdomen a small amount of ascitic fluid escaped. Presenting into the wound was a huge, thick-walled, ovarian cyst and coursing over its mesial anterior surface, inseparably attached to it, was a markedly dilated, thickened pyosalpinx. (Fig. 1.)

When several loops of densely adherent small bowel were separated by blunt and sharp dissection, the cyst wall was torn and some serosal denudation of bowel occurred. The

latter was taken care of by approximating sutures. About 2 liters of thin, purulent fluid were suctioned from the cyst and a salpingo-oöphorectomy was performed.

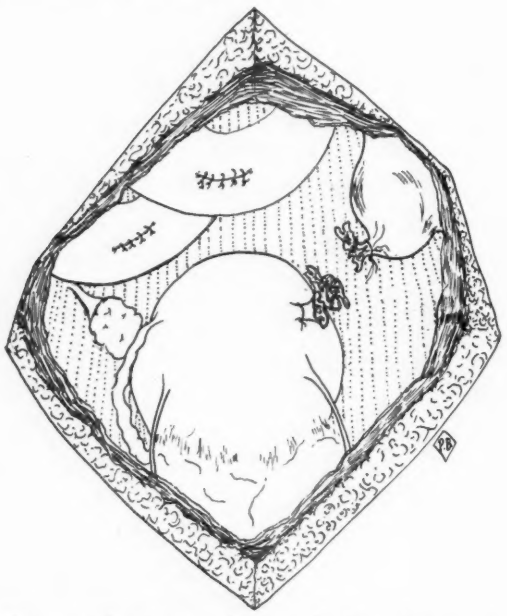

FIG. 2. Sketch showing markedly edematous left infundibulopelvic ligament after removal of tubo-ovarian cyst.

The left infundibulo-pelvic stump, approximately seven to ten times its usual size, was markedly thickened, edematous and pale. (Fig. 2.) Palpation suggested a thrombosis or a thrombophlebitis of its inner vessels extending proximally along the left common iliac vein.

It seemed, therefore, that this finding was the cause of the clinical picture of sepsis, the marked edema of the left lower extremity and the saphenous vein tenderness. The prognosis in view of this operative finding still remained hopeless. The postoperative clinical course, however, proved to be so atypical for thrombophlebitis and sepsis that our diagnosis was considered questionable, if not incorrect.

For two days after laparotomy the patient was apathetic, dull and toxic and her condition showed no improvement; but on the third day there was a radical drop in temperature, and from then on sensorium became more lucid. Edema of the left lower extremity and left lower abdominal and lumbar walls slowly but progressively decreased. A second transfusion was given at this time for the marked secondary anemia.

Except for a small decubitus ulcer over the coccygeal area, which eventually healed, convalescence was entirely uneventful. On December 14, 1939, twenty-four days after operation, the patient was discharged as cured. On a recent visit to our out-patient department she was found to be in good health and complained of no sequellae from the operation or obstruction in the left lower extremity.

The pathologic diagnosis of the removed specimen, reported by Dr. Ginzler, was tubo-ovarian abscess with the tube opening directly into the ovarian cyst lumen. The cyst fluid revealed no growth on culture.

DISCUSSION

In retrospect, the two outstanding points which have been clarified are: the cause of swelling in the lower extremity, and the cause for the clinical picture of thrombophlebitis and sepsis, which postoperatively proved to be more apparent than real.

In both humans and animals the toxicity of sterile pus is attested undeniably by clinical proofs too numerous to mention. The clinical picture of sepsis is often brought to a spontaneous and spectacular close by the simple release of encapsulated sterile pus. In this patient, it is conceivable that the sterile pus of the huge tubo-ovarian abscess drained slowly but constantly into the ovarian vein and the accompanying lymphatic system, thus producing the clinical syndrome of thrombophlebitis and sepsis. Within forty-eight hours after removal of the primary focus there was a spontaneous improvement, which rarely is observed in true septicemia or vein infection.

The operative finding, namely, thrombophlebitis (edema and induration), of the common iliac and ovarian vein (infundibulo-pelvic ligament enlargement) is explained on the basis of pressure, followed by venous and lymphatic stasis. Thus the pathogensis of the left lower extremity, as well as perivascular and retroperitoneal edema is explained by pressure phenomenon, while the symptoms of sepsis can be accounted for by toxic absorption.

Since with time, self-sterilization of pus tubes and ovaries takes place, it is not surprising that approximately one-half yield

negative bacteriologic cultures. The bacteria in order of frequency are gonococcus 15 per cent, streptococcus 8 per cent, acid-fast organism 5 per cent, staphylococcus 1 per cent, Bacillus coli 2 per cent. Hunter Robb isolated Bacillus proteus and Robert T. Frank reported Streptococcus hemolyticus in an 8 year old abscess.

Gebhardt found 226 instances of sterile contents in 409 pus tubes and Wertheim reported that 122 out of 206 pyosalpinges were sterile.

Unilateral pyovarium is not uncommon. In one hundred cases of pyovarium, A. Martin found 77 unilateral abscesses and 83 were accompanied by salpingitis.

In this case, since the lesion was unilateral and developed to a greater degree in the ovary, the origin may have been salpingitis causing secondary tubal agglutination over a course of many months. Many of these lesions have a puerperal origin and others, with or without tubal involvement, follow intra-uterine manipulation, principally early instrumental intervention of pregnancy.

The syndrome of sepsis which was present in spite of a negative blood culture, namely, high fever, clouding of the sensorium and the profoundly toxic condition of the patient, is satisfactorily accounted for by the amount and intensity of toxic absorption from local infection in the ovarian cyst, the pelvic soft tissues, and the perivascular retroperitoneal spread along the common iliac veins. The pathogenesis of these has been explained.

Torsion, rupture, thrombosis and hemorrhage are the usual complications of large, ovarian cysts.

In this case the complication was aseptic necrobiosis of a huge ovarian cyst with infiltrative pelvic and perivascular cellulitis causing toxic absorption as well as actual pressure on the common iliac and ovarian veins and their lymphatic systems, which produced edema of the lower extremity.

The combination of these give rise to the local picture of thrombophlebitis and the general impression of sepsis, and is so rare and unusual that it seems worthy of presentation.

RECONSTRUCTION OF THE SCALP FOLLOWING EXCISION OF MALIGNANCY*

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CARCINOMA of either the basal or squamous cell type is not infrequently encountered on the scalp. Due to the anatomical characteristics of this region, the problems of adequate surgical treatment and plastic reconstruction must be considered together.

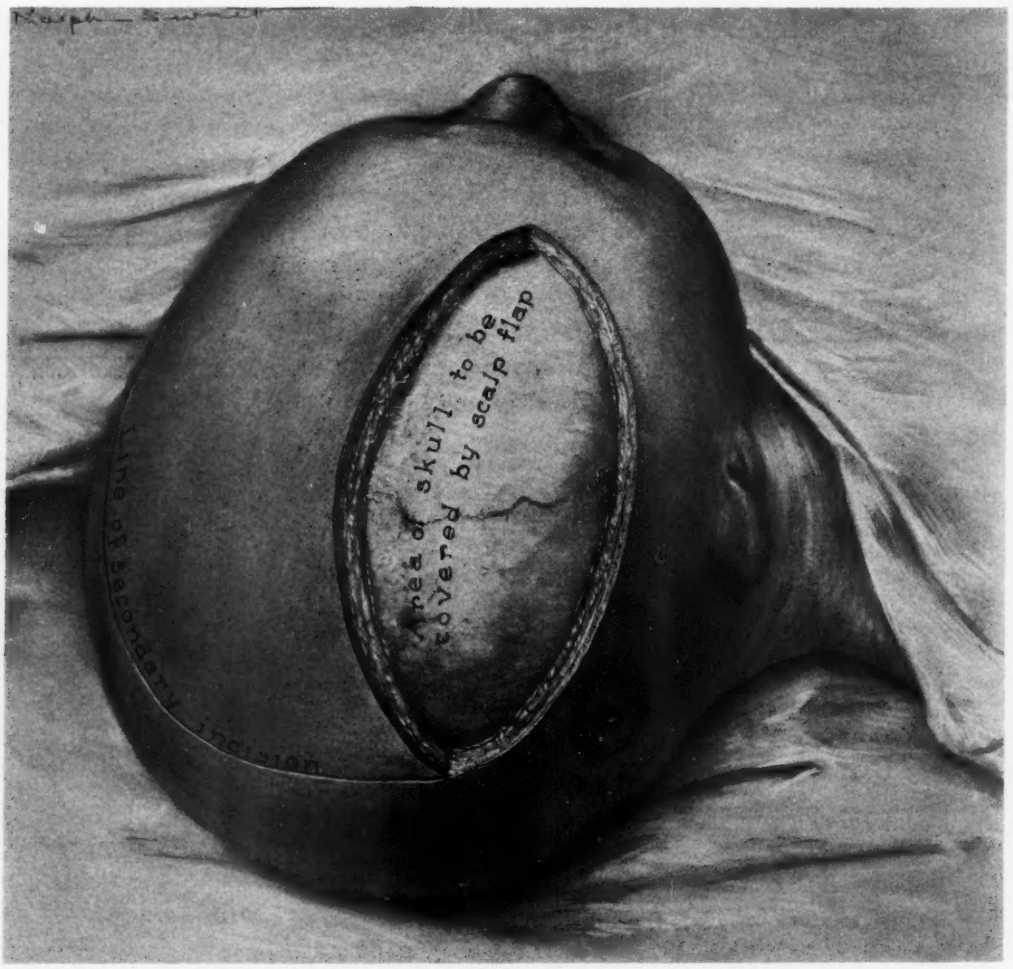

FIG. 1. The involved area has been removed by an elliptical excision down to and including the periosteum. The line of incision for the formation of a rotation flap is indicated.

Malignant changes may occur at the site of old unstable scars following scalp burns or other forms of trauma. The common sebaceous cyst so frequently seen in this region, is not generally regarded as a potential location for the development of an epithelioma, but such an occurrence is not extraordinary. Some investigators have noted malignancy in as high as 4 per cent of such cysts of the scalp. In Caylor's series of 236 sebaceous cysts, twelve were found to be malignant.

In general, epitheliomas in this region are slow to metastasize and slow to invade the deeper layers. Possibly due to the density

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of the galea aponeurotica, such lesions more often spread laterally or form papillary masses projecting from the surface.

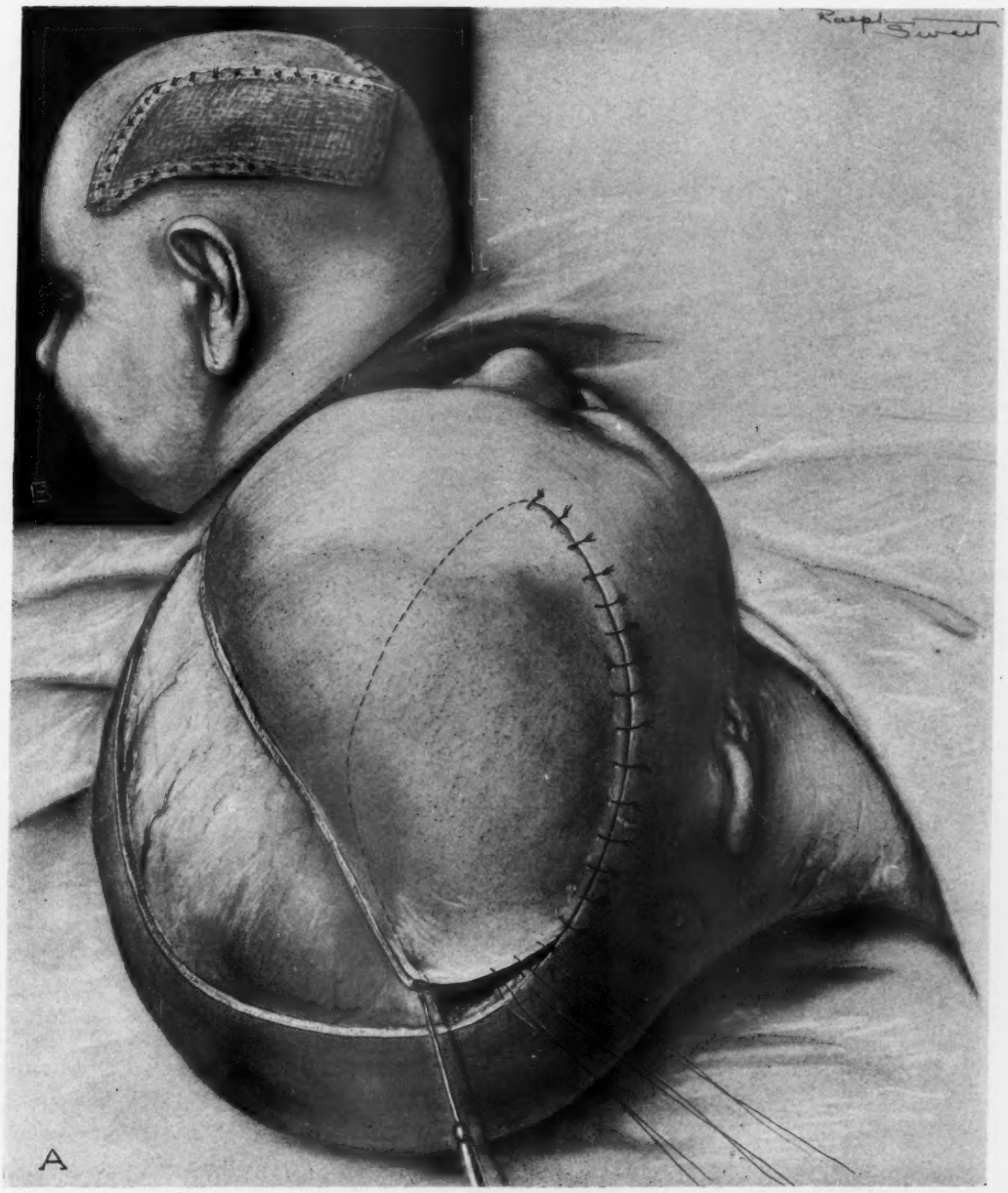

FIG. 2. A, the scalp flap has been shifted into position over the initial defect and partially sutured. B, graft and Tulle Gras have been sutured to the remaining defect, overlapping the edges.

Occasionally, however, invasion occurs early, and for this reason treatment must be directed deeply for the greatest margin of safety.

There are three principal methods of treatment in general use: irradiation, electrocoagulation and surgery. Each of these has its advantages and disadvantages, and each no doubt has proved efficacious in experienced hands. Irradiation in doses necessary to produce the desired effect on a cancer which has progressed to the deeper layers of the scalp, may also be the cause of complications of a serious nature. Necrosis of bone and endarteritis of cerebral vessels are sequelae which have been known to follow this therapy. Pendergrass et al. have recently reported cases of three patients with malignancy of the scalp treated by irradiation, all of whom died from intracranial infection. The conclusion drawn

after postmortem examinations was that the infection followed a lowering of the resistance of that portion of the brain exposed to massive doses of *x*-ray.

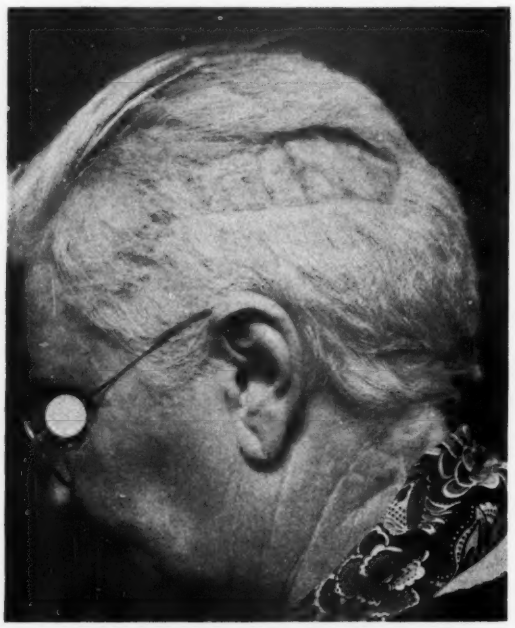

FIG. 3. Showing the grafted area approximately three months after operation.

Electrocoagulation has been used on superficial lesions with success, but it is difficult if not impossible to direct such therapy down to the bone without producing bony necrosis.

Radical surgery, which is the only type of surgery indicated, can excise these growths down to and including the periosteum without producing any of the above mentioned complications. Such treatment will create large scalp defects, but with proper planning, these can be reconstructed with suitable plastic procedures. The following case history of a carcinoma of the scalp arising from a sebaceous cyst exemplifies the type of reconstruction which may be employed:

Mrs. M. M., aged fifty-nine, was first seen on August 20, 1938, at which time she complained of two wens on the scalp. Two years previously a large wen had been removed from approximately the same location. On examination two sebaceous cysts about the size of walnuts were seen close together, one of which adjoined the scar from the prior operation. On palpation, the cyst overlying the scar felt harder and more firmly fixed to the tissues than the other. The scar itself presented a few small hard nodules along its length. A biopsy of the cyst was diagnosed as squamous cell carcinoma. It was therefore decided to excise the entire area containing the cysts and scar.

On August 26, 1938, under general anesthesia, the involved area was excised down to and including the periosteum. The defect thus produced measured 5 by 3 inches. Since there was now no base upon which to place a free graft, a rotation flap of adjoining scalp was raised up, shifted into position and sutured over the defect, using Deknatel interrupted sutures. The area left by this maneuver had a base of subaponeurotic tissue, which was suitable for the application of a graft.

Using the right thigh as a donor area, several intermediate grafts were cut and spread on Tulle Gras, raw surface uppermost. This technic facilitated the handling of the grafts. The skin was next placed in apposition with the area to be grafted, with edges overlapping. Sutures of Deknatel No. 1 were placed to anchor the graft to the surrounding scalp. Moistened gauze sponges, a marine sponge, and an Ace bandage furnished a pressure dressing. The donor area was dressed with layers of vaseline gauze. On September 5, 1938, the tenth postoperative day, the dressings were removed, sutures removed and the graft was found to be a complete take. The head was rebandaged in a similar fashion for another ten days after which time further dressings were unnecessary.

SUMMARY

Three methods of treatment for malignancy of the scalp are discussed: radiation, electrocoagulation and surgery, with the advantages and disadvantages of each. A case history of a carcinoma of the scalp arising from a sebaceous cyst is described, with emphasis on the reconstruction of the scalp following radical surgical excision.

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INTESTINAL OBSTRUCTION CAUSED BY GALLSTONES

CASE REPORT

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A RECENT article from the Mayo Clinic[1] states that "the rarest of all the reasonable ways in which the intestine may become obstructed is by gallstones." The authors reported ten cases that have been observed at the Mayo Clinic, the diagnosis having been made either at operation or necropsy. Moore,[2] in 1925, estimated that 400 cases had been recorded.

The common mechanism of such obstruction is by the formation of a cholecystoenteric fistula from perforative cholecystitis, although of more rare occurrence may be cases of perforation of peptic ulcer or carcinoma. The site of obstruction has usually been in the terminal portion of the ileum. The case here reported is similar in both respects, being from a perforative cholecystitis and the final obstruction resulting from impaction of the stone in the ileum. It differs in that the signs and symptoms might be interpreted as characteristic of an obstructive body passing through the intestine.

CASE REPORT

Mrs. L. M. K., a house-wife, age 68, had been in poor health for ten years. After the birth of her ninth child, she had a very severe phlebitis in her right leg, with a marked residual lymphedema. Since 1928, she had suffered from diabetes which was comparatively mild and controlled by diet. In 1930, following an acute upper respiratory infection, there had been an attack of acute nephritis with edema and hypertension, and a resulting chronic nephritis. During 1936, she had suffered several attacks of pain in the upper right quadrant which were diagnosed as gallstone colic. On May 14, 1937, she had an attack of severe generalized, cramplike, upper abdominal pain. The pain also radiated to her back on the right side. She vomited several times with the onset of pain. During the next two days, the pain was said to have shifted from the upper right quadrant across the midline to the left, then to the left lower quadrant. It occurred in severe paroxysms between periods of comparative quiesence.

During my absence from the city, another physician attended her and administered morphine to relieve the pain. This was repeated several times in the next two days but she continued to have pain and to vomit. I first saw her on May 17. Examination revealed a very sick woman complaining of intermittent cramp-like pains in her abdomen and constant nausea and vomiting. She stated that she had a bowel movement on the morning of the onset but none since. Her temperature was 100 degrees and pulse 105. She was dehydrated with coated tongue and flushed cheeks. Chest examination revealed nothing of significance. Her abdomen was uniformly distended. The upper half was fairly soft with but slight tenderness over the gallbladder region; the lower half was very tender with muscle spasm on both sides. Urinalysis revealed: specific gravity, 1.011; albumin, negative; sugar, negative. The sediment contained many pus and epithelial cells and tissue débris. The white blood cell count was 6000, with 77 per cent polymorphonuclears.

With a diagnosis of acute intestinal obstruction of unknown origin, immediate laparotomy was done under a spinal anaesthesic. When the abdomen was opened, a large quantity of serous fluid and a greatly distended small bowel were found. Exploration revealed obstruction about 3 feet proximal to the cecum by an ovoid body. The intestine was incised longitudinally and the mass removed. Closure was done transversely by a Connell suture of intestinal catgut and a peritoneal layer of Lembert sutures of silk. Further exploration revealed a mass of adhesions between the gallbladder and duodenum. These adhesions were not disturbed. The abdomen was closed with drainage tubes in place.

The obstructing body, when examined, proved to be a gallstone 3 by 4¾ cm. in size, with a smooth surface except for a deep facet in one end.

FIG. 1. Gallstone, which caused intestinal obstruction.

The postoperative condition of the patient was good until the fifth day when signs of peritonitis appeared. She grew worse and died on the ninth postoperative day. An autopsy examination was not performed.

SUMMARY

A case of acute intestinal obstruction caused by impaction of a gallstone, following formation of a cholecystenteric fistula, is reported. This case might have been diagnosed preoperatively from (1) the previous attacks of gallstone colic, and (2) the shifting character of the pain as revealed by the history in the presence of all signs of an obstruction.

In reviewing the case, it seems that had I been more alert to this possibility, the diagnosis might have been made from the latter point since any other cause of an obstruction in this patient would have remained at a fixed location, without the shifting pain and tenderness which occurred with the downward passage of the stone.

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FETAL RESUSCITATION AFTER SEEMING DEATH*

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THE exact moment of death in a human organism is difficult to fix. A heart may stop only to start again, breathing may cease and be effectively re-established, and both breathing and heart action may be present in an organism in which vital physiologic processes are otherwise already arrested. Cessation of cellular activity after failure of respiration and circulation proceeds at varying rates in different tissues.

Therefore, while in the subsequent case report the condition of the fetus is referred to as "seemingly dead," it is done advisedly in anticipation of the irrefutable argument that anything physiologically "dead" cannot be revived. The purpose of this report is to stimulate exhausting attempts to revive seemingly dead babies in which no gross organic pathology is noted. Also it discredits the commonly accepted belief of extreme sensitivity and early death of anoxemic brain tissue, and emphasizes the need for positive measures to revive babies born with "asphyxia neonatorum pallida."

CASE REPORT

Mrs. I. G., a twenty-two year old primagravida, whose estimated date of confinement was October 8, 1937, was awakened at 1:30 A.M. October 1, 1937, when the membranes ruptured. There followed occasional slight pains and a sensation of bladder pressure. When voiding at 6:30 A.M. she noticed approximately eight inches of cord protruding from the vagina. She was admitted to the hospital by ambulance at 7:10 A.M. with faint, slow pulsations of the cord present. On arrival in the delivery room at 7:15 A.M., twenty inches of cord were prolapsed, there were no pulsations, no fetal movements were felt and no fetal heart was heard on careful abdominal auscultation. The cervix was four and one-half fingers dilated with a double footling breech presenting. Since the pelvis seemed ample and signs of fetal life had only recently disappeared, accouchement forcé was performed, with some difficulty encountered in delivering the after-coming head through the incompletely dilated cervix.

The baby was born at 7:38 A.M., eighteen minutes after cord pulsations and other criteria of fetal life were known to be absent. Infant asphyxia pallida, flaccidity and absent heart sounds were noted, with no precordial or umbilical beat and no respiratory efforts. Coramine ampule 1 intramuscularly was given two minutes after birth. Four minims of adrenalin were given intracardially four minutes after birth and forty seconds later spasmodic cardiac contractions were detected. Intratracheal insufflation by Flagg apparatus was begun and fifteen minutes after birth and thirty-three minutes after the fetus was seemingly dead, the baby initiated breathing efforts. He was placed in a tub of warm water and 5 per cent to 95 per cent CO_2-O_2 given by inhalator for thirty minutes. The first cry was timed twenty minutes after birth.

Prognosis was still guarded due to the prolonged cerebral anoxemia.

The subsequent course while in the hospital was uneventful. The baby nursed well and left the hospital on the fourteenth day slightly over its birth weight of 3,150 Gm.

The child was examined again October 9, 1939, at the age of two. He is physically and neurologically normal and his mental development is advanced beyond the normal for that age.

CONCLUSION

The conclusion to be drawn from this experience is that seemingly dead, newborn babies should be given intracardiac adrenalin in small dosage and forced pulmonary ventilation in conjunction with other therapy, in attempts to revivify them. The rare occasions of good results (two in our experience) make the fruitless efforts in the vast majority worth while.

* From The Margaret Hague Maternity Hospital, Jersey City, New Jersey.

UTEROVAGINAL FISTULA AND PREGNANCY

REPORT OF A CASE ASSOCIATED WITH AMPUTATION OF THE CERVIX WITH CLOSURE OF THE CERVICAL CANAL TREATED BY CESAREAN SECTION

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A REPORT of this case is warranted because of its extremely unusual features, a similar case not being found in a thorough search of the literature.

A multipara, white, 35 years of age, at full term, was admitted to the hospital with the history of several moderately severe vaginal hemorrhages during the previous six to seven hours. There were no uterine contractions. The patient was in good condition with a pulse rate of 90 per minute. The fetus appeared full term in size, position left occiput posterior, head nonengaged, fetal heart rate 144 per minute, good quality. Admission diagnosis of placenta previa was made and the writer was asked to see the patient.*

Abdominal findings were as above. On rectal examination the cervix could not be felt. Vaginal and speculum examination revealed the following: complete absence of the cervix with closure of the endocervical canal, there being merely a dimpling 2 to 3 mm. in depth impermeable to a probe at the site of the cervix. Three cms. to the right and 2 cms. anterior to this dimpling an opening was seen, from which blood was oozing. On examination this was found to be a uterovaginal fistula, 2 cms. in width, which showed a recent tear and hemorrhage. The fetal head was felt through this opening. The placenta was not in reach of the examining finger, though deep exploratory palpation was naturally avoided.

The previous obstetric and operative history of the patient is of pertinent interest: There had been one other pregnancy, terminating, after four days of labor in a midforceps delivery of a male child, weighing 5 pounds, 13 ounces. This child, now 8 years of age, has suffered ever since birth from mental retardation and convulsive seizures, probably resulting from cerebral damage from the prolonged labor and forceps.

Four years following the birth of this child the patient had a "high amputation of the cervix." Her hospital stay was featured at this time by repeated attacks of fever and pain in the lower portion of the abdomen. It is uncertain whether the uterovaginal fistula developed at the time of the patient's prolonged labor and was not seen or not repaired at the time of her operation, or whether it resulted from closure of the endocervical canal at the time of operation with subsequent infection. It is more probable that the fistula dates back to the time of her delivery. Since the birth of her first child the patient has been menstruating normally with complete absence of pain, whereas previously, dysmenorrhea was marked. This fact would speak for the production of the fistula at the time of labor. Certain it is that the patient became pregnant by the penetration of the spermatozoa through the vaginouterine fistula.

To avoid irreparable damage to the pelvic structures (who would have dared to deliver this woman from below?) a two-flap low cesarean section (laparotrachelotomy) was done, with the birth of a normal living female child, weighing 7 pounds, 5 ounces. The placenta was situated well away from the lower uterine segment. The postoperative course was uneventful; the wound healed by primary union and the patient and baby were discharged on the thirteenth postoperative day.

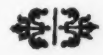
It was believed in this particular case that one could only get into difficulties and gain nothing by an attempt to repair the fistula and re-open the endocervical canal. The patient has been so informed and is abiding by this decision.

*The history from this point was withheld from the patient's physician, as she was operated upon without his knowledge and did not want to antagonize him.

The author is grateful to the patient's private physician, Dr. M. Graff, for permission to publish this interesting case.

SUMMARY

A case is here reported of a uterovaginal fistula with a fullterm pregnancy, associated with a previous "high amputation of the cervix," with complete closure of the cervical canal. Origin of the fistula is discussed. Pregnancy resulted from the penetration of spermatozoa through the vaginouterine fistula. Treatment was by low cesarean section with the birth of a normal child and an uneventful recovery of the mother.



Fibro-myoma of the uterus is by far the commonest tumor of that organ. It produces hemorrhages at or between the menstrual periods, and anaemia results.

The brief excerpts in this issue have been taken from "Physical Diagnosis" by Richard C. Cabot (William Wood & Company).

New Instruments

AN APPARATUS TO FACILITATE THE TREATMENT OF COLLES' FRACTURES*

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THE apparatus to be described below will be better understood by a brief review of the treatment of Colles' fracture. The fracture must first be satisfactorily reduced with particular care to correct not only the posterior displacement but also the radial displacement of the distal fragment of the radius. An anesthetic, general or local, is required for this reduction. Gas-oxygen inhalation anesthesia, supplemented occasionally by ether, is the usual method of choice. Following reduction, the forearm, wrist and hand must be kept in the position best suited for the maintenance of the reduction by an assistant or assistants while some form of splint is being applied. The position is usually one of more or less flexion and varying degrees of ulnar deviation of the wrist. The method of maintaining the position is usually one involving the use of plaster of Paris, either in the form of anterior and posterior slabs, or a circular plaster cast from the elbow to the heads of the metacarpals. It is necessary to maintain anesthesia until the cast has hardened.

Several technical difficulties are encountered in this procedure. The first is the necessity for an assistant to hold the reduced fracture in the proper position while the cast is applied. Even expert assistants are in the way and very often make careful, snugly fitting casts difficult to apply. More often than not, the assistant available is not particularly skillful and his fingers are a hindrance to the application of the cast. As a result there may be changes in the reduction position from the optimum first obtained by manipulation. The second difficulty is the necessity for continued anesthesia as one applies the cast and until it hardens. The third difficulty is the fact that the surgeon very often sacrifices the lightness of the cast by adding excessive plaster so that the cast will harden more quickly and make unnecessary prolonged holding of the wrist and hand in the desired position.

The apparatus designed to obviate these difficulties is illustrated by the accompanying photographs. (Figs. 1 and 2.) It is mounted on a wooden board which measures approximately 24 inches by 7 inches. At its center is a 3 inch high, upright tube, (A), which sets into a base. Into this tube slides a slightly smaller tube, (B), of similar length. The height and position of the inner tube with respect to the outer tube is controlled and locked by a set screw, (C). Attached to the inner sliding tube at its upper end is a ball and socket joint, (D), so made that by twisting a threaded cap, it may be tightened or released. The ball has mounted on it a round metal shaft 1 inch long and ¼ inch thick (E). Its upper end has welded to it a rectangular shank, (F), ⅜ by ¾ of an inch. Resting on this square shank is a curved wrist rest, (G), which is made of thin-rolled steel. At its midportion it has a

* From the Orthopedic Service of Beth Israel Hospital, Boston, and the Orthopedic Service of Cambridge Hospital, Cambridge, Mass.

rectangular opening, (E), just large enough to get securely on the rectangular end of upright. One end of this bar curves up to a much higher point than the opposite end and then curves back on itself to make a sort of hook.

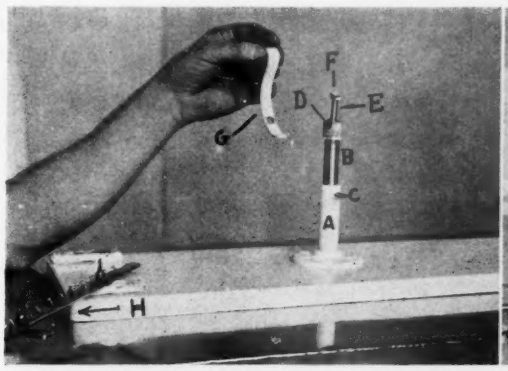

Fig. 1. This view demonstrates the entire apparatus with the wrist rest removed from the rectangular end of the metal post. Note square opening in wrist rest.

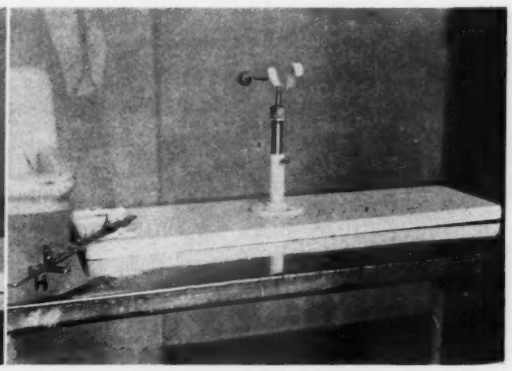

Fig. 2. Apparatus completely assembled for use with left wrist. Wrist rest in site; traction bar placed on left hand slot for traction in position of ulnar deviation.

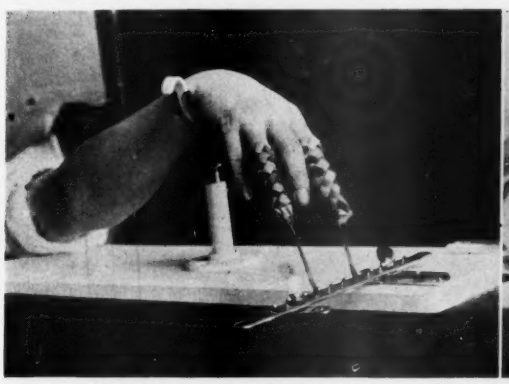

Fig. 3. Fracture reduced (right wrist). Finger traps applied to index and ring fingers; rubber band traction to traction bar.

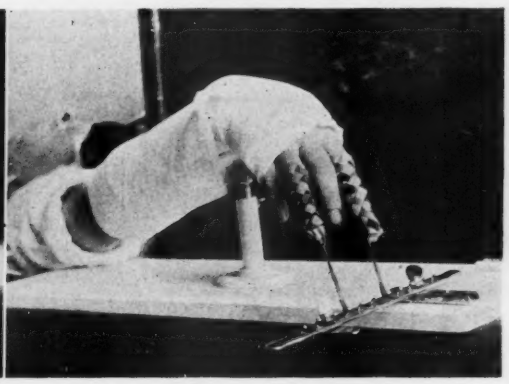

Fig. 4. Sheet wadding applied.

At one end of the apparatus is a traction device, (H), which swings into any position and may be attached to a slot at either side of the end of the board. This traction bar may be locked in any position by a set screw and has hooks on it for rubber band traction. The bar may be so placed, therefore, to secure traction with varying degrees of ulnar deviation for either hand.

USE OF THE APPARATUS

The fracture is reduced under general anesthesia and then immediately placed on the apparatus as per Figure 3. If it is a left hand the metal rest of curved bar, (G), is rotated 180 degrees and reset on the square end, and the traction rod is slid out of its groove and placed in the groove on the other side of the board. A piece of thin felt or cotton is placed between the wrist and the wrist rest, (G). If a stockinette has been used, the latter is not necessary. Finger traps of the Japanese bamboo variety are applied to the index and middle or ring finger, two of these usually sufficing. These finger traps when pulled grasp the fingers snugly. Rubber bands have been passed through the ends of the traps. The other end of the rubber band is attached to the hooks on the traction bar. The particular hooks they are attached to are determined by the amount of ulnar deviation that is desired. By elevating the tube, (B), more flexion may be obtained.

Placing the reduced wrist in the apparatus takes but a moment or two. The moment this is done the anesthetic may be stopped and the patient allowed to recover from it. Because the patient is lying flat with elbow extended and wrist locked, the position of the fragments is secure from the effects of any motion of the patient's trunk. If one desires, the elbow may be strapped to the board by a strap and buckle, although this is not necessary. Then, without the need of any assistants it is possible to wrap sheet wadding around the forearm, wrist and hand. (Fig. 4.) Following this plaster of Paris is applied over the sheet wadding. This can be done leisurely, molding it carefully, particularly along the radial side of the second metacarpal bone to maintain the position of ulnar deviation. Figures 5 and 6 demon-

Fig. 5. Cast applied; end on view.

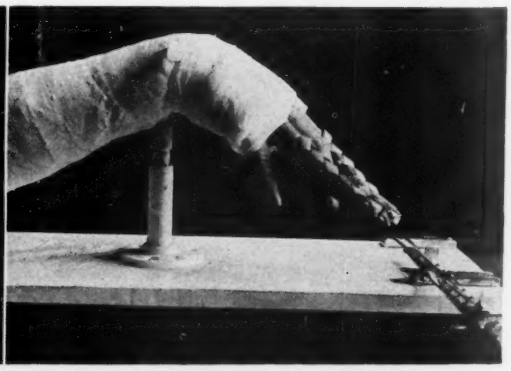

Fig. 6. Cast applied; lateral view.

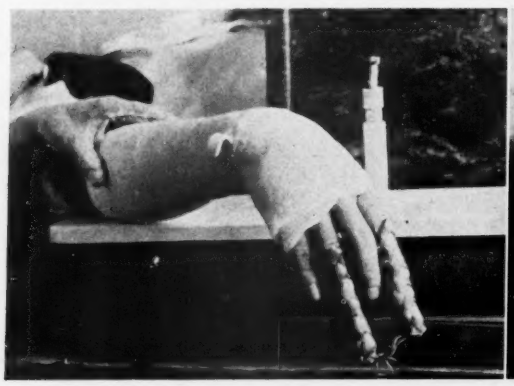

Fig. 7. Forearm with cast applied, lifted off metal post. Note curved end of wrist rest protruding through cast.

Fig. 8. Wrist rest rotated slightly out of cast.

Fig. 9. Wrist rest more completely rotated out of cast.

Fig. 10. Wrist rest completely rotated out of cast.

strate the iron wrist rest with its curved end protruding. Figure 6 also shows the metal shaft, (E), protruding from the bottom of the cast. Because there is no need for hurrying, the cast may be made very light and the arm with cast applied may be kept on the apparatus until it is completely dry and firm. Then the cast with the wrist rest or curved bar, (G), incorporated in it is lifted off the rectangular end of the metal post, (E). (Fig. 7.) At this point the reason for bending the curved bar back on itself becomes obvious. It will be appreciated that this curved bar rests under the wrist, and between it and the wrist is either a small piece of felt or stockinette. Lying against the outer surface of the bar is the sheet wadding wrapped around the entire arm. By placing the index finger under the hook of the curved bar and pulling it up in a curved direction which follows the curve of the bar, it slides out very easily. (Figs. 8, 9 and 10.) The small slit opening through which it slides out and the small ¼ inch opening on the anterior surface through which post, (E), is slipped, may either be left uncovered or covered with a turn of plaster of Paris bandage. The cast is then trimmed in the usual manner.

CONCLUSION

An apparatus which facilitates the treatment of Colles' fractures is described. It makes necessary only a very short period of anesthesia and eliminates the need of an assistant. It makes possible better, lighter and more closely fitted casts. Its use minimizes the possibility of changes in position of the fracture during application of the cast.

A SIMPLE HOLDER FOR VENTRICULOSCOPE OR BRAIN CANNULA*

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IT is often necessary, during ventriculography or the tapping of a ventricle for other reasons, to allow the cannula to remain for more than a few minutes at a time. The protruding end must not be allowed free play in the burr hole through which it is inserted. Even when held by an assistant with a forcep, there is often some undesirable lateral motion of the deep end of the instrument in brain tissue.

The small device illustrated* was designed to eliminate this hazard. It is a steel sphere, with a protruding handle, perforated to receive loosely either the Adson brain trocar or the small examining ventriculoscope of the same diameter, which we use. The outside diameter of the sphere is the same as that of the Hudson burr used to make the bony opening, so that it will fit fairly snugly in the burr hole. The lower end of the sphere is notched to give the sphere a slight spring.

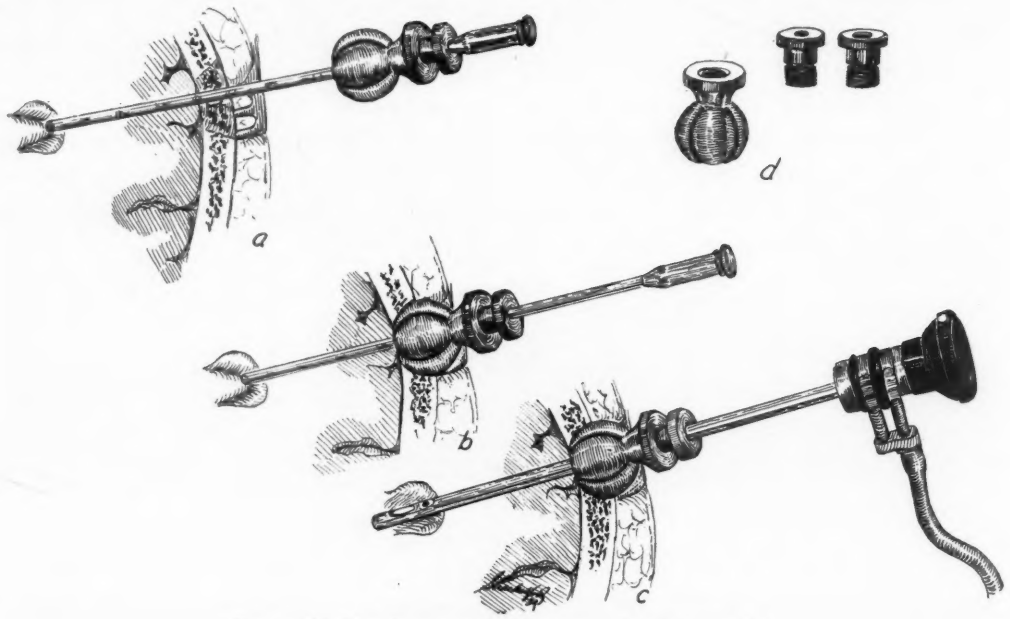

FIG. 1. Holder for ventriculoscope or brain cannula.

When used, the cannula, or ventriculoscope, is passed through the opening of the sphere and then inserted as nearly through the center of the burr hole as the position of the gyrus and surface vessels will allow. It may be inserted at any angle. (Fig. 1A.) When the instrument in use reaches its proper position in the ventricle, the small sphere is moved down the shaft until it engages the burr hole. The trocar is then held free of lateral motion, while it can be advanced or withdrawn as desired. (Fig. 1B.)

* These instruments were made for me by Mr. Alex Barna of Duquesne, Pennsylvania. The illustrations were made by Miss E. M. Shackelford of the Oliver Research Laboratory.

* From the John C. Oliver Memorial Research Laboratory, St. Margaret Memorial Hospital.

PROCTOSCOPE GUIDE FOR ELECTRODES AND SNARES

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NEW YORK, NEW YORK

DIFFICULTY in accurately placing the tip of long proctoscopic electrodes, particularly when they are at all flexible, led me to devise the guide herewith illustrated. The principle is that of the cue bridge used in billiards and pool.

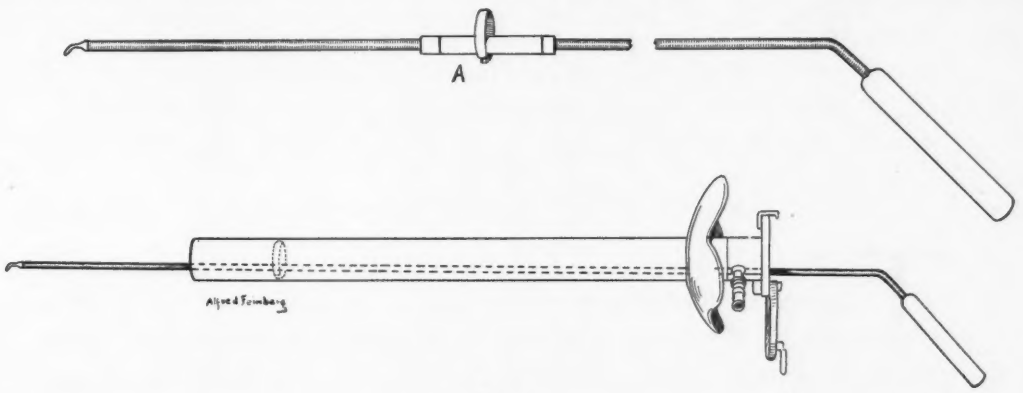


Fig. 1.

Guide A consists of a ring that has an easy fit for the proctoscope and a portion through which the electrode passes. The electrode slides easily through the guide and can be shifted to any position in the proctoscope channel. By manipulating the proctoscope and the electrode, the tip may be accurately and surely directed to any desired spot. This instrument has been used, with great satisfaction, with both electrodes and snares.

There are many different proctoscopes on the market, and a slightly different guide will be required for each. Any good instrument maker can fashion a fitting guide at small expense.

The guide here illustrated was made by the American Cystoscope Makers, of New York.

Selected Book Review

BONE GRAFT SURGERY IN DISEASE, INJURY AND DEFORMITY*

By Fred H. Albee, M.D., LL.D., SC.D., F.A.C.S.

Assisted by Alexander Kushner, M.D.

THIS book will have a wide appeal to the orthopedist, the surgeon who does reconstruction surgery and to certain general surgeons whose field or practice extends to those patients requiring bone graft surgery. That the author is a pioneer in this surgical domain goes without further comment. In 1915, he wrote a book on this subject that had a wide distribution. Even then his accomplishments in the field of bone graft surgery were considerable, and he was known in the civilized world wherever bone surgery was done. The writer remembers attending a lecture given by Dr. Albee early in 1917, and watching moving pictures showing his technic of bone graft surgery.

VALUE OF BONE GRAFT SURGERY

The author tells us that he has incorporated those procedures which have stood the test of time. For the most part he deals with procedures he himself uses, but also has included procedures by other surgeons of mature judgment. Bone graft surgery is utilized today in an ever increasing variety of ways: The reconstruction surgeon is able to cope with the unfortunate sequelae of industrial and road accidents; the therapy of congenital absence of many bones can now be undertaken with greater assurance than formerly; the Albee Bone Graft spine fusion operation has made the treatment of a wide variety of spinal affections less formidable; and it is believed that the graft peg is the ultimate solution of those cases of central fracture of the neck of the femur when the ligamentum teres has been ruptured at the time of the fracture, a frequent occurrence. These are

* New York, 1940. D. Appleton-Century Company, Inc.

but a few of the conditions for which this type of surgery will prove beneficial.

THE BOOK

The book has nine chapters: The General Principles of Bone Grafting, Armamentarium of the Orthopedic Surgeon, Spine Fusion,

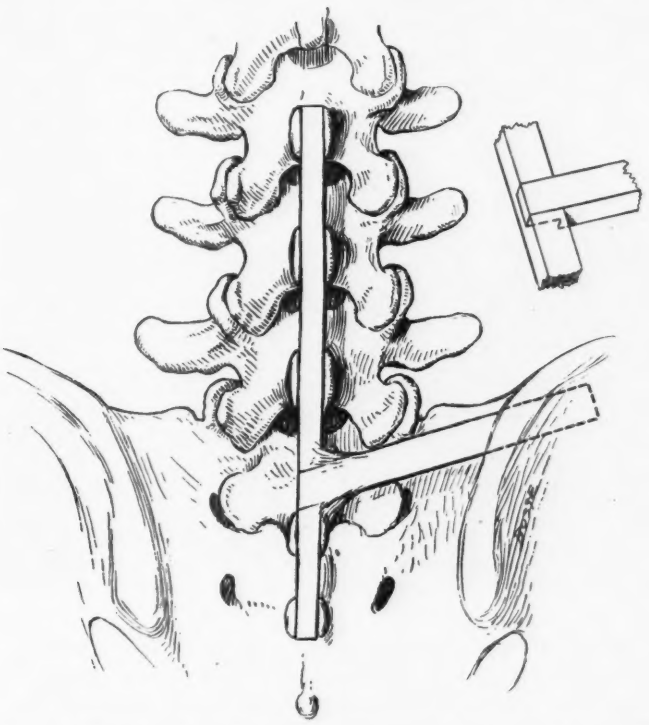
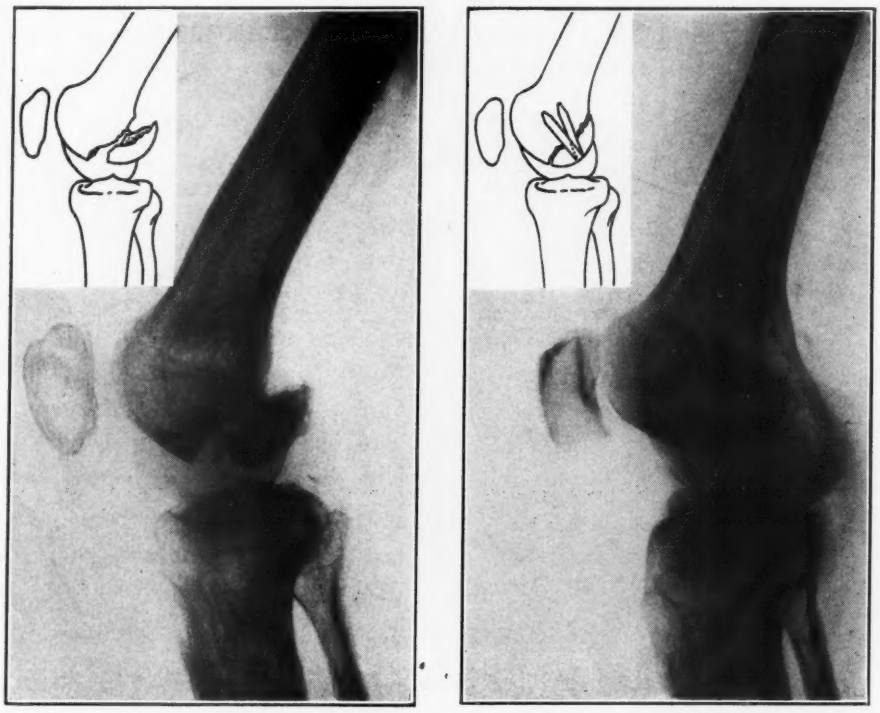


FIG. 1. Diagram from the roentgenogram of an actual case of tuberculosis of the last lumbar vertebra and the right sacro-iliac joint. The spine graft was inserted by the author's regular technic for Pott's disease. The graft controlling the sacro-iliac joint was joined by a carpenter's half mortise to the spinal graft (see small upper right-hand drawing). The callus uniting the two grafts is indicated. The graft was joined to the posterior wing of the ilium by shaping it into a wedge end which was forced into a split in the ilium made by an osteotome. (Figure 76, in Albee's Bone Graft Surgery, D. Appleton-Century Company, Inc., originally in Albee's Orthopedic and Reconstruction Surgery, W. B. Saunders Co.)

Bone Graft Surgery of the Hip Joint, Bone Graft Surgery of Ununited Fractures, Bone Graft Surgery for Replacement of Bone, Plastic Bone Graft Surgery, Arthrodesing Bone Graft Operations

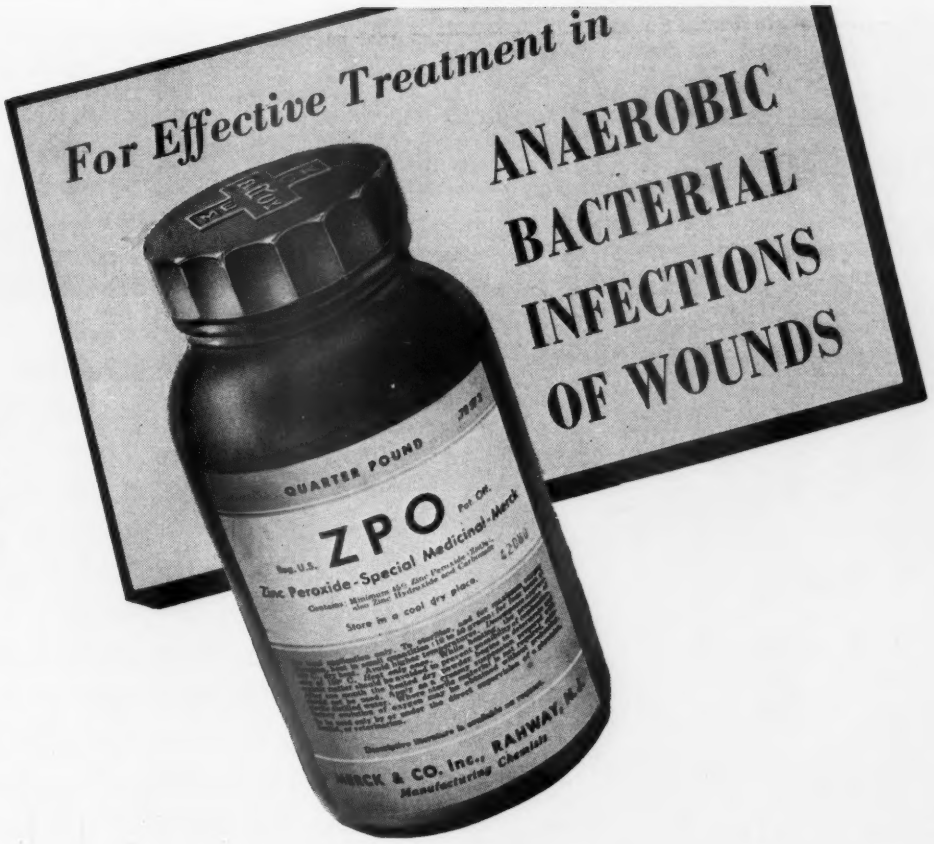
and Bone Block Operations. It contains approximately 300 illustrations and has an ample Bibliography at the end of each chapter. There are also an Index of Authors and an Index of Subjects.



A B

FIG. 2. A, ununited fracture of femoral condyle of two years' duration. B, bony union after coapting the fractured fragments with two bone graft pegs. (Figure 146, in Albee's Bone Graft Surgery, D. Appleton-Century Company, Inc.)

It is a readable, concise, scientific book on a subject that is more important today than ever before, written by a pioneer and master of this type of surgery.



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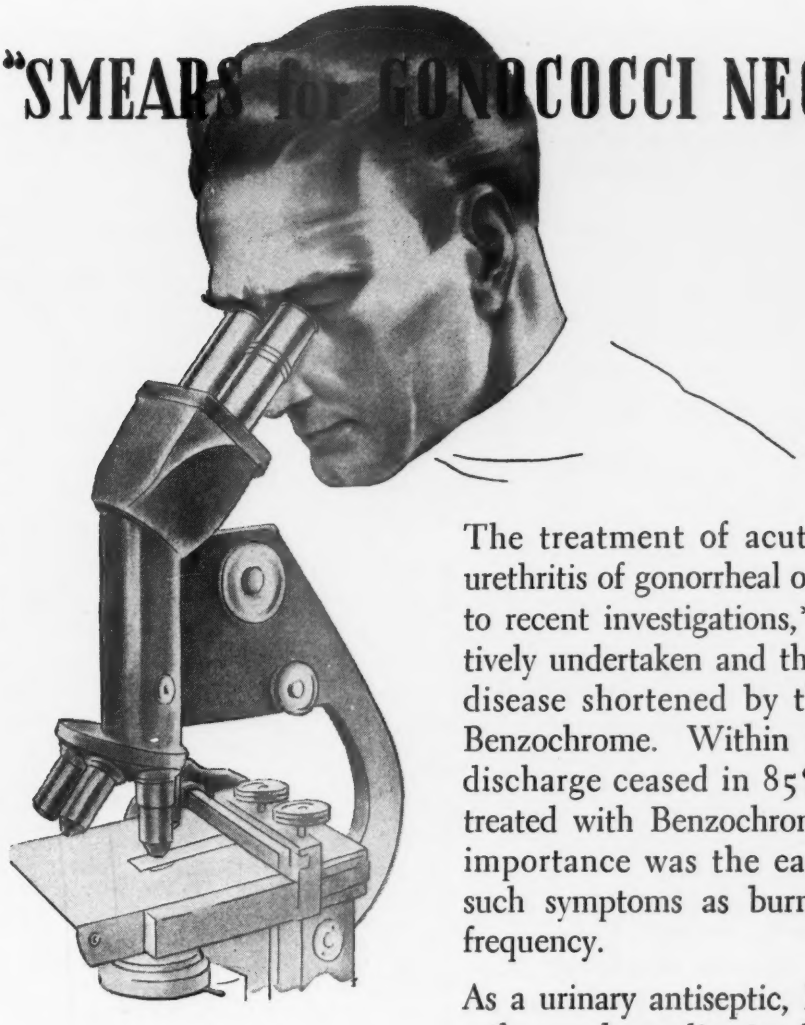

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Boston, May 12–14, 1941. (Secretary—DR. W. BLAIR MOSSER, Kane, Penna.)

AMERICAN ASSOCIATION FOR THE SURGERY OF TRAUMA

Seigniory Club, Montreal, Que., May 29–31, 1941. (Secretary—DR. RALPH G. CAROTHERS, 409 Broadway, Cincinnati)

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Hot Springs, Va., September 11–13, 1941. (Secretary—DR. JAMES R. BLOSS, 418—11th St., Huntington, W. Va.)

AMERICAN ASSOCIATION OF RAILWAY SURGEONS

Chicago, September 8–10, 1941. (Secretary—DR. R. B. KEPNER, 547 W. Jackson Blvd., Chicago)

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Boston, November 3–7, 1941. (Secretary—DR. FREDERIC A. BESLEY, 215 N. Sheridan Rd., Waukegan, Ill.)

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Washington, D. C., September 1–5, 1941. (Secretary—DR. RICHARD KOVACS, 2 East 88th Street, New York)

AMERICAN GYNECOLOGICAL SOCIETY

Colorado Springs, May 26–28, 1941. (Secretary—DR. RICHARD W. TELINDE, Johns Hopkins Hospital, Baltimore)

AMERICAN MEDICAL ASSOCIATION

Cleveland, June 2–6, 1941. (Secretary—DR. OLIN WEST, 535 N. Dearborn Street, Chicago)

AMERICAN ORTHOPAEDIC ASSOCIATION

Toronto, Can. June 9–12, 1941. (Secretary—DR. C. W. PEABODY, 474 Fisher Bldg., Detroit)

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Louisville, Ky., October 29–November 1, 1941 (Secretary—COL. JAMES M. PHALEN, 1870 Wyoming Ave., N.W., Washington, D. C.)

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Mexico City, August 10–14, 1941. (Secretary—DR. CHARLES H. ARNOLD, 903–15 Terminal Bldg., Lincoln, Nebr.)

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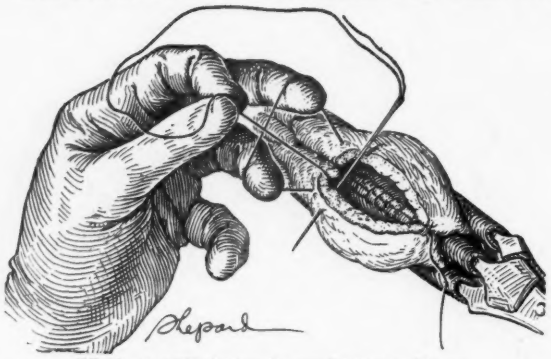

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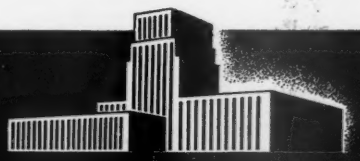

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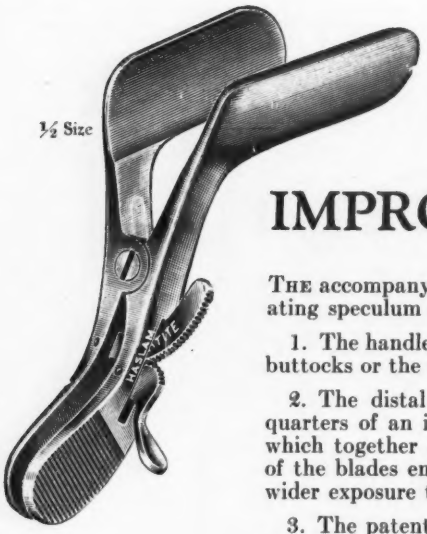

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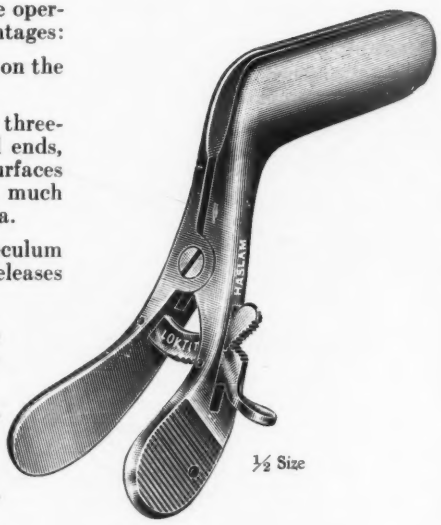

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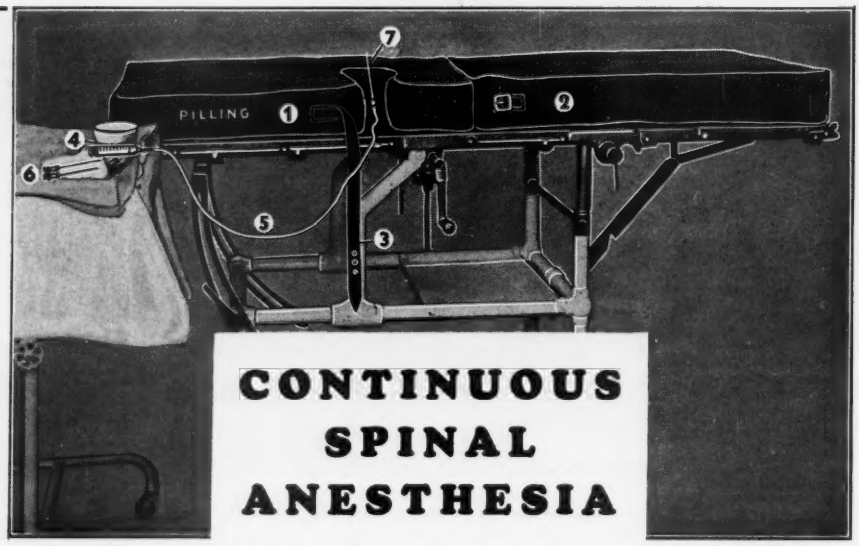

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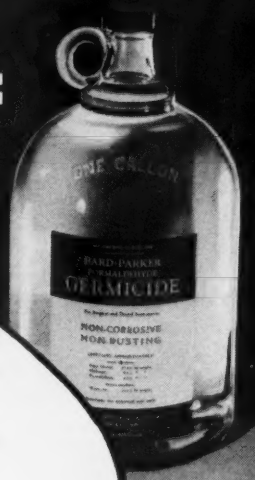

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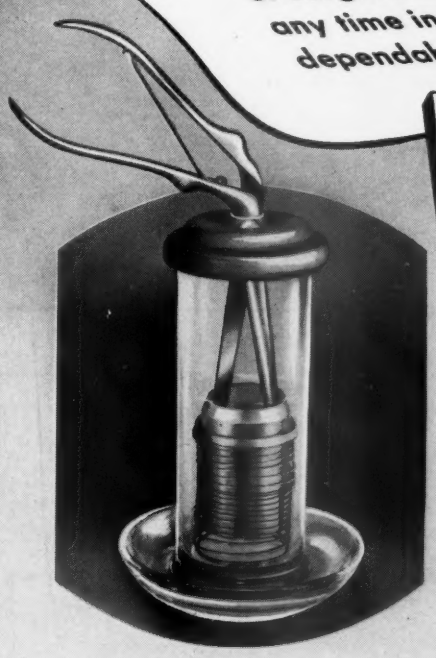

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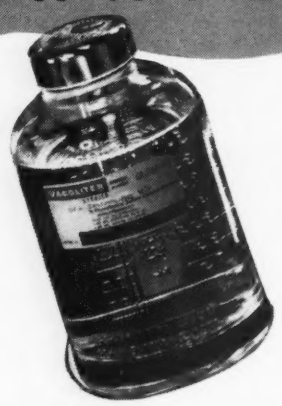

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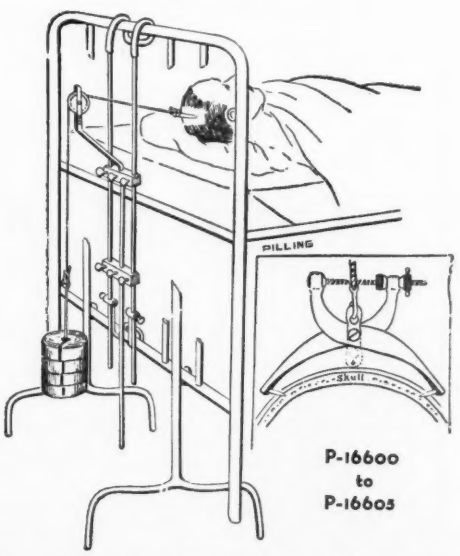

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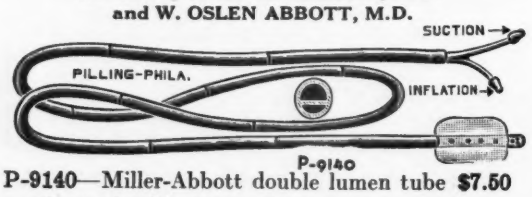

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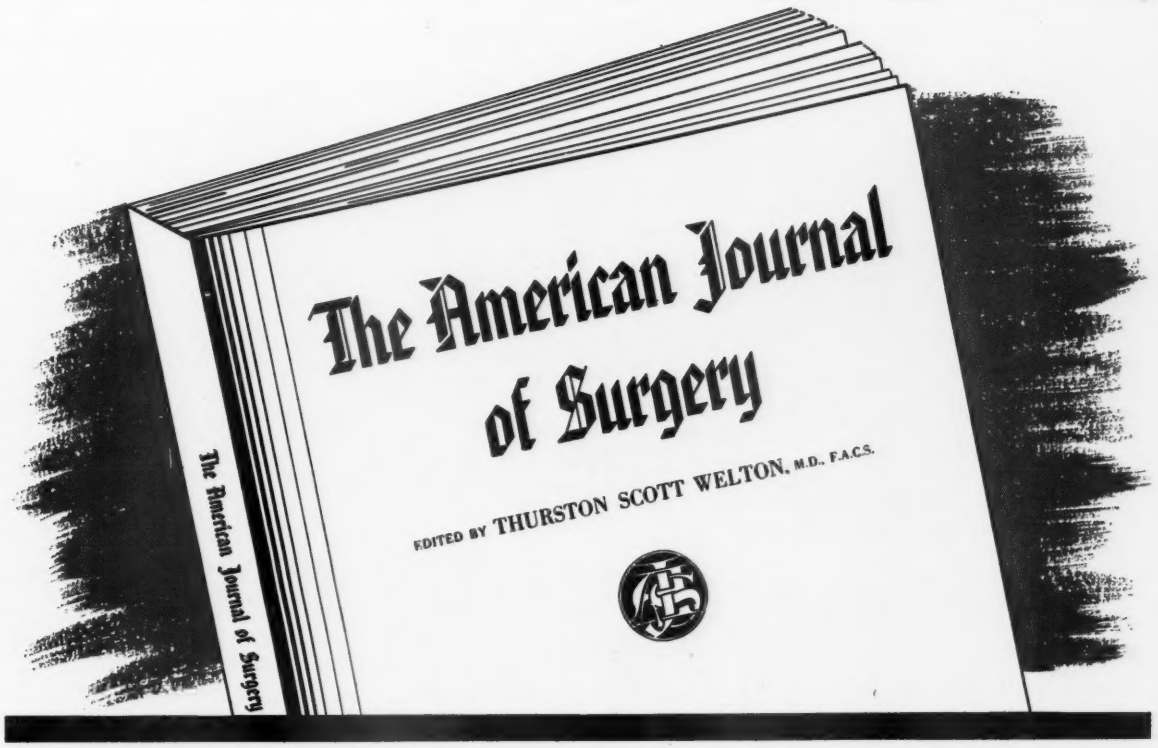

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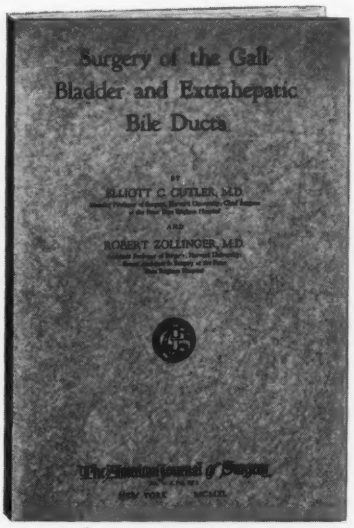

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